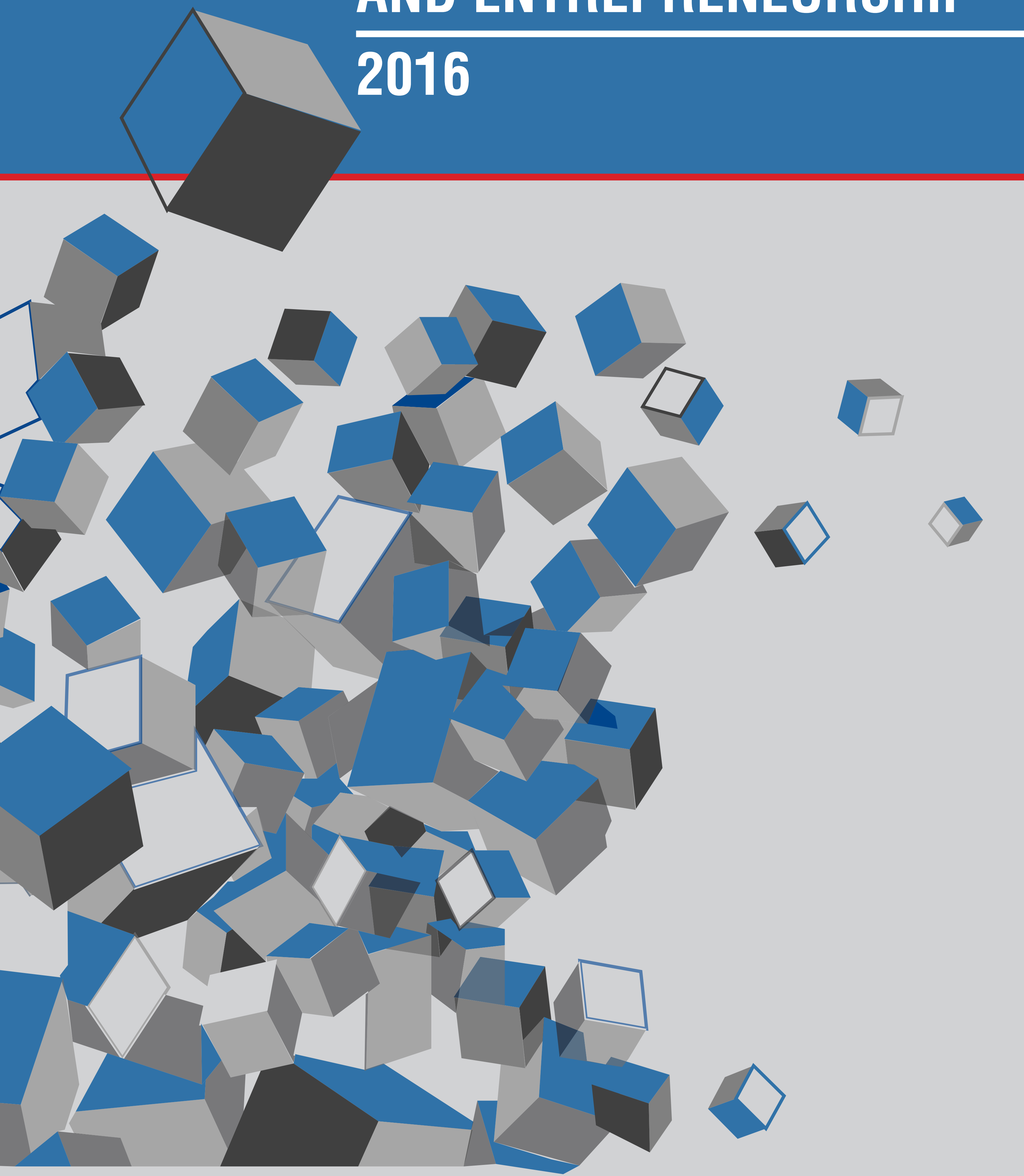
CHINA AND RUSSIA REPORT ON INNOVATION AND ENTREPRENEURSHIP

2016



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FOREWORD AND ACKNOWLEDGEMENTS

Both Russia and China faced periods of rapid growth that allowed them to join the top list of global players, however, currently their economies are in the midst of a challenging transition. Previous growth models seem to be exhausted and need revisiting. Fostering innovations seems to be the only way to return to track of sustainable development. We believe that analysis of development paths of Russia and China could provide insights valuable for policy makers. Moreover, the detailed review of innovation infrastructure of both countries could be of value for companies aiming at entering mutual markets.

This consolidated report summarizes the main findings of the research project jointly conducted by the Skolkovo Foundation on the Russian side, and the Tsinghua University and TusPark on the Chinese side. The project was at reviewing innovative performance and presenting the big picture of national innovation systems of Russia and China.

The report has four main parts:
• Part I provides the framework for analysis of the role that science, technology and innovation play in the context of economic development.
• Part II analyses China's national innovation system, focusing on key indicators, innovation archetypes and state policies for promoting innovation.
• Part III presents a review of Russia's innovation system, including major metrics and description of public governance of the innovation system.
• Part IV outlines the current state of economic cooperation between Russia and China and describes the result of survey conducted among Russian high-tech startups on cooperation with China.

The Chinese review is based on two papers "Experience relating to the construction of science parks and special economic zones in China" and "Profile of China's innovation and entrepreneurship". The authors are thankful to detailed reports, published by McKinsey Global Institute on China. These papers have greatly contributed to the research framework. OECD review of China's innovation policy was also a source of valuable insights and guidance.

The overall research work from the Russian side and development of the consolidated report was led by Evgeny Sheenko. The valuable contribution and thoughtful input by Vasily Belov, Senior Vice-President for Innovations, and Ekaterina Inozemtseva, Vice-President for Strategy and Investments of the Skolkovo Foundation are greatly appreciated.

The Chinese expert team was led by Herbert Chen, COO of the Tus-Holdings, who developed the overall design of the research. The project coordination and management was conducted by Hongmei Yang, Assistant Dean of Tsinghua University Tuspark Research Institute for Innovation. The expert team also included Lina Yang from Joint Institute for China-Russia Strategic Cooperation, Tsinghua University, and Biyang Lin and Wei Ge from Tsinghua University Tuspark Research Institute for Innovation. Sophia Shang, Tus-Holdings, worked under translation of the report into English.

PART I

ECONOMIC DEVELOPMENT AND INNOVATION

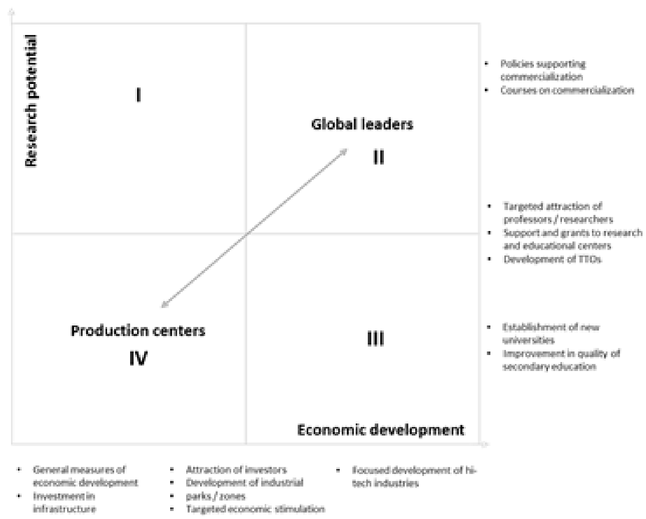
When assessing an economy's capacity for innovation, it is common to use a view that is based on a number of quantitative indicators considered to be good proxy for innovative capabilities. The most common metrics focus on data such as R&D spending, number of PhDs granted, annual patent applications, and research papers published. While these metrics may indicate improved capabilities in certain areas of innovation, they do not catch and measure innovation in its broadest sense, which includes not only scientific inventions, but also successful commercialization of ideas and technologies, novel business models, and innovation in production processes. Nor do these measures of capacity provide any information about how to unlock hidden innovation potential and which measures should be taken by policymakers.

In our research we have developed a matrix-based framework, classifying countries by their innovative capabilities. The macro-based view was enhanced by an industry-specific approach based on the model of industrial archetypes of innovation developed by McKinsey Global Institute and used for detailed analysis of the Chinese innovative system. Combination of frameworks made it possible to develop a holistic approach towards assessment of the innovation potential of the country both at the macro and industry level.

At the first stage of analysis the countries can be mapped in two dimensions – research potential and economic development. The research potential is measured through patent applications per 1 million of population. The economic development is estimated by GNI per capita. It can be argued that these indicators are relatively simple and may have certain drawbacks, but for the purpose of our research the relative simplicity of indicators outweighs possible generalization. The combination of research potential and economic development provide four quadrants as presented on a matrix below.

This matrix allows us to make a "quick and dirty" mapping of countries based on their relative strength. Quadrant II (Innovation economy leaders) contains countries with the highest research potential and economic development. These countries have favorable conditions to set up university-driven innovation centers focused on research that are able to become knowledge hubs

Exhibit 1 Gap analysis matrix and key policy measures



of the global innovation ecosystem. Elements of Triple Helix - academia and business are mature enough to play an active role in creating innovations. Policymakers' objective in terms of innovation will include both strengthening of research potential and growth of economic development.

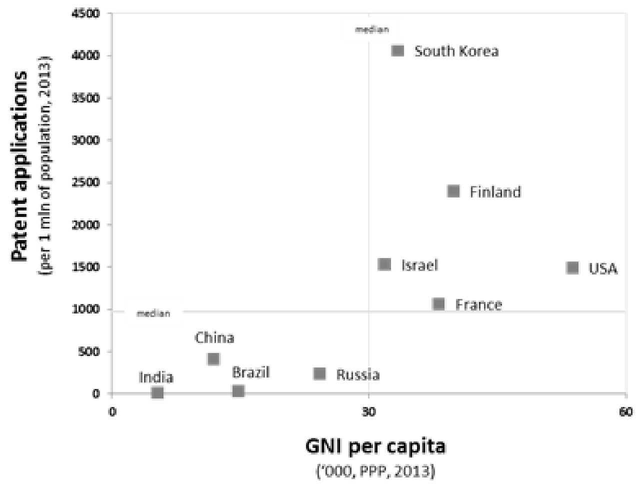
Quadrant IV (Production centers) is a location for countries which have competitive benefit in terms of low wages but lack research potential. These countries could pursue policy of developing industrial parks and further transforming them into innovation centers through adoption of technologies and growing necessary research skills (moving to QIII and furthermore to QII). Growth of innovations in such countries is majorly government driven due to low level of maturity of business and academia. The key policymakers' objective is to improve economic development through establishing industrial parks and further transforming them into innovation centers by adopting technologies and growing necessary skills.

To illustrate this approach, Russia's and China's comparative position across these dimensions mapping of nine countries were provided on Exhibit 2 below. The countries are mapped on a diagram along with the peer countries which represent various innovation types.

The matrix provides a general insight on suggested roadmap for policy measures. Roadmap for economic development may include the following set of measures:

• *Low level:* investment in infrastructure, attraction of investors, launch of industrial parks for

Exhibit 2 Distribution of countries on a gap matrix



Source: WDI database

mass-production and obtaining technologies and developing initial critical mass of educated workforce.

• *Medium level:* targeted economic stimulation, further development of industrial parks and zones, attraction of foreign investors, building potential for hi-tech production

• *High level:* focused development of hi-tech industries and breakthrough technologies

Roadmap for building research potential would suggest the following actions:

• *Low level:* Improvement in the quality of secondary education and establishment of new universities

• *Medium level:* Targeted attraction of research staff and professors and providing support (financial and organizational) to research and educational centers. Development of TTOs to foster transformation of research into commercialization.

• *High level:* Setting up regulatory framework favorable for commercialization of research, developing educational courses on commercialization.

Alongside with the general guidance to the policy makers, this distribution could provide industry-level insights. In order to do this, it should be enhanced by framework of innovation archetypes developed by McKinsey Global Institute[1].

The four innovation archetypes introduced in the McKinsey model are as follows: science-based innovation, engineering-based innovation, customer-focused innovation and efficiency-driven innovation. Innovation archetypes add industry- or even firm-level insight on the general screening, made by the gap matrix, see the detailed description below.

Science-based innovation involves the development of new products through the commercial application of basic research. Science-based innovation is critically dependent on the research potential. It comprises industries on the innovation frontier, such as biotechnologies, semiconductors, and aerospace. These industries heavily rely on scientific innovation and may spend 15 to 30 percent of revenue on R&D. The innovation process may involve basic research and takes a long time to develop and even longer to pay-off. Working on an innovation frontier requires tremendous R&D expenditures and includes intensive international cooperation as R&D requires involvement of top-notch talents.

Sustainable progress in science-based innovation is impossible without close cooperation between academic research and companies supported by corporate R&D able to provide prototypes to be put into mass production. This type of innovation is also heavily dependent on the accumulated knowledge base as the incumbent countries have collected a large patent portfolio which is difficult to form within a short period of time. And what is more important the market for such goods is getting more and more concentrated due to huge investments in production. Success in science based innovation industries require a nation to provide government funding for basic research and fund science education as 'public goods'.

This type of innovation activities is primarily the attribute of Global leaders (QIII), as it requires mature innovation ecosystem and takes significant time to build capabilities. Russia has made significant efforts to rebuild capabilities and return to the group of global leaders, however due to objective (time and financial resources required) and subjective reasons (government-centric type of innovation ecosystem, lack of cooperation between business and academia, and disconnectivity from the global knowledge exchange due to geopolitical situation) the progress is so far relatively limited to such industries as space technologies, and nuclear energy to name a few.

Engineering-based innovation involves the design and engineering of new products and often involves the integration of technologies from suppliers and partners. Industries that rely on engineering-based innovation include commercial aviation, auto manufacturing, and communication equipment. These industries have moderate to high R&D intensity, typically spending 3 to 13 percent of sales on R&D, and can have product life cycles of five to ten years or longer.

Knowledge in these industries is typically based on accumulated learning that is acquired over time through experimentation and learning by doing. For companies to succeed in engineering-based innovation, they need access to professionally trained talent, mature project management culture and a supportive environment that provides strong intellectual property protection. Engineering-oriented companies benefit from strong industry clusters, policies that increase networking and access to global sources of technology, talent, and knowledge.

Countries located in between quadrant III (high economic development, limited research potential) and partially quadrant I (high research potential, limited economic development) have the competitive edge in pursuing this type of innovation. One of the key success factors is the mature and developed industrial ecosystem ready to absorb new technologies developed by science-based leaders and move it to the mass production.

International cooperation is a key factor of engineering-based innovation as all industries assume diversified network of suppliers. Building a competitive product is possible only based on competitive selection of best available supplies. Disconnectivity from the global markets may significantly hamper the development time, product capabilities and price. Commercial aviation is one of the most illustrative examples, as all the modern aircrafts are built in close cooperation of hundreds of suppliers from many countries. Progress in engineering-based innovation also requires high involvement of private business in innovation activities, both of large corporations and SMEs.

Efficiency-driven innovation is aimed at improvements to reduce cost, shorten production time, and enhance quality in manufacturing. Efficiency-driven innovation is particularly relevant in capital- and labor-intensive industries, such as commodity chemicals, textiles, electrical equipment, construction machinery, and to some extent mineral resource extraction. The innovation process depends in on-depth knowledge of production processes and materials to reduce cost while maintaining or improving quality or production level. This involves novel approaches in product development, supply-chain management, manufacturing, or service delivery. A strong cluster ecosystem is important for such type of innovation as it promotes collaboration and knowledge exchange between suppliers, manufactures, and customers.

Production centers (quadrant IV) tend to benefit most of all from this type of innovations. Success in implementation is significantly dependent on the government policies and activity of private business in technology upgrade.

Customer-focused innovation involves solving consumer problems through advances in production, services, and business models. Industries in this category include Internet software and services, appliances, and consumer packaged goods. These industries are characterized by high marketing intensity and short development cycle, with rapid iterations of new concepts. Due to focus on local needs and regulations, local innovations often have advantages.

The innovation process in customer-focused industries depends on understanding and addressing consumer needs. Access to large consumer markets is important for understanding customer needs as well as for scaling up innovations rapidly. Companies in customer-focused industries benefit from large local demand, easy access to capital, and policies that support entrepreneurship. There seem to be no barriers for this type of innovation in terms of research potential and economic development, so it is open for all countries with significant market. Small and medium enterprises are key players on this field, as they are close to customers, flexible and eager to easily develop customer-focused products and services.

Paths of Russia and China on a map:

• China started as production center and gained technologies through openness. Now it has significantly increased its economic development and needs to go up the innovation value chain. The move up the innovation chain requires extensive development of scientific capabilities and commercialization mechanisms.

• Russia has some certain capabilities in engineering and scientific-based domains. However it heavily relies on the government financing and in order to achieve a sustainable growth Russia needs to move towards corporate-centric financing and improving connectivity between R&D and business.

[1] *The China Effect on Innovation, McKinsey Global Institute, October 2015*

PART II

CHINA'S INNOVATION PROFILE

The role of innovation

China has come a long way towards developing the innovation economy and is currently regarded as one of the great success stories of the recent time. The country has transformed from the economic system characterized by low level of technology development and autarchy to one of the global innovation center open for international trade and technology exchange. For almost three decades, GDP growth has averaged nearly 10 percent a year, which is the fastest long-term expansion by a large economy in the recent history. Prolonged period of economic growth allowed for tectonic improvement in living conditions – more than 800 million people were lifted out of poverty. With a total population of over 1.3 billion, China has recently turned into the second largest economy and is gaining its role in the global economy. Though the investment-led growth model that helped to achieve a record progress has served well, rapid economic ascendance has brought on many challenges and risks as well, including challenges to environmental sustainability, internal imbalances and pressures related to availability of human capital and resources. Continued growth fueled by foreign investments and internal debt is hardly sustainable and raises risks of hard-landing in the future.

Continuation of growth requires policy adjustments and finding a new set of growth drivers. The Chinese government addresses the challenges in the 12th and 13th Five-Year Plans designed for 2011 – 2015 and 2016 – 2020 respectively, which envisage rebalancing economy with transition towards more sustainable growth mode. The rapid growth of over 10 percent achieved in previous years is substituted by a relatively modest target of 6.5 percent in the 13th Five-Year Plan, reflecting focus on quality of development.

Previous phases of China's growth have been underpinned by reforms transforming the entire economic system. These reforms, including the launch of the "Open-Up" policy, have contributed to deregulation of the economy and extensive transfer of technologies and foreign investments that build the industrial infrastructure.

Under the targeted government policy, China has gradually turned in the global production center. The next step is to improve the innovation capabilities and make a shift from "Made in China" to "Designed in China".

China's government proclaims determination to build a full-scale high-performing national innovation system. The overarching goal stated in the 2006 "Medium- to Long-Term strategic Plan for the Development of Science and Technology" is to make China an "innovation-oriented" society by the year 2020 and later one of the global innovation economies. The current policy measures focus on a new innovation-based model which would enable China to reach its development targets, reinforcing the rise of the middle-class and accelerating progress towards fostering innovative capabilities in science and engineering to become a full-fledged advanced economy.

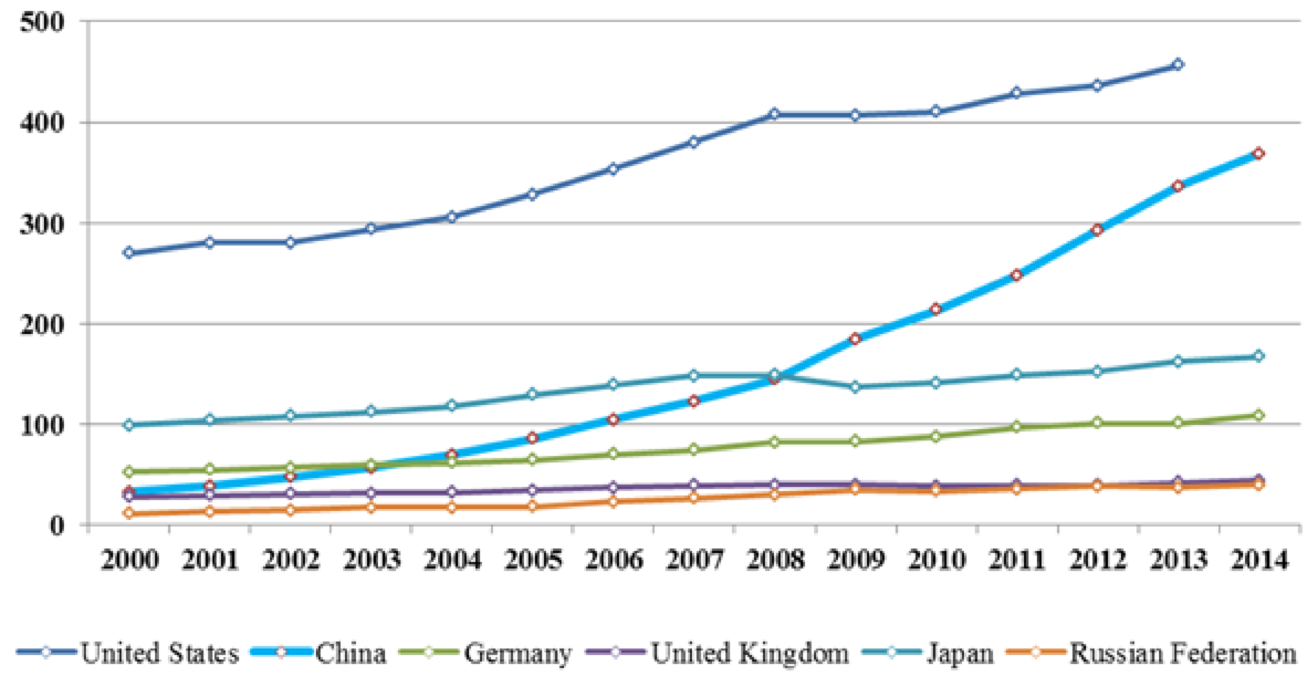
What is more important is that China's innovative development which started as a state-centric and gradually changed to a corporation-centric with high reliance on technology transfer is becoming more and more based on indigenous and home-grown innovations. New "Mass Entrepreneurship, Universal Innovation" reforms call for development of grass-root innovation and intend to fuse high-tech and innovative entrepreneurial activities which would drive the next phase of growth.

Key indicators of innovative development

China has proved to be successful in building and scaling up the resource base for innovation development. As the research and development activities constitute the core of innovation, the amount of expenditures on R&D and personnel are the common measures of innovation development and primary indicators of the level of efforts a country makes to foster innovation activities.

Measured by the amount of R&D expenses, China has already become a global leader and is second to the United States only. Over the last 10 years, in terms of total amount of spending, China has demonstrated miraculous growth and surpassed Germany, Britain and Japan. China's total investment in R&D has risen from 30 billion USD in 2005 to more than 200 billion in 2014.

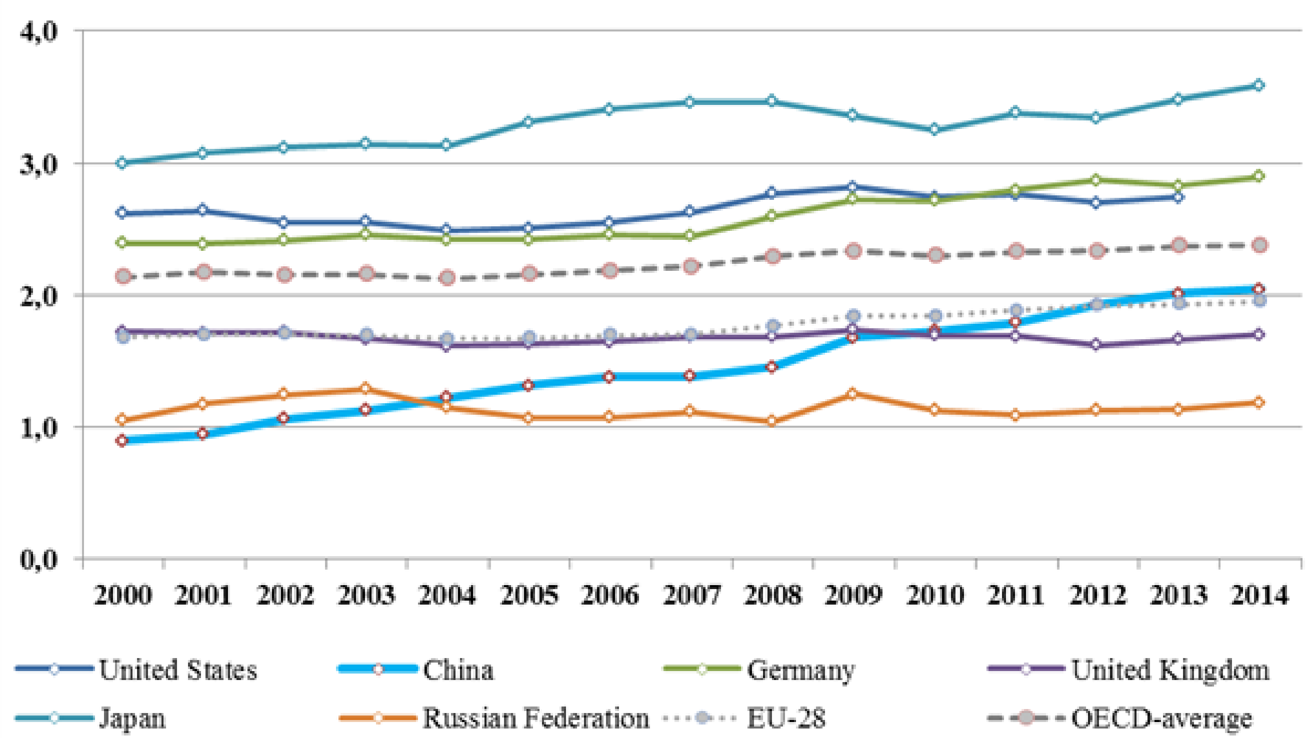
Exhibit 3 Gross Domestic Expenditure on R&D (billion USD, current PPP)



Source: OECD Main Science and Technology Indicators

China's R&D intensity measured as percentage of R&D expenses to GDP has also demonstrated a remarkable growth. Currently it accounts for approximately 2.0% of GDP on R&D, which is comparable to the level of some developed countries, including the Netherlands and the United Kingdom. Yet it is still below the level of such leaders in spending as Japan (3.59%), South Korea (4.29%).

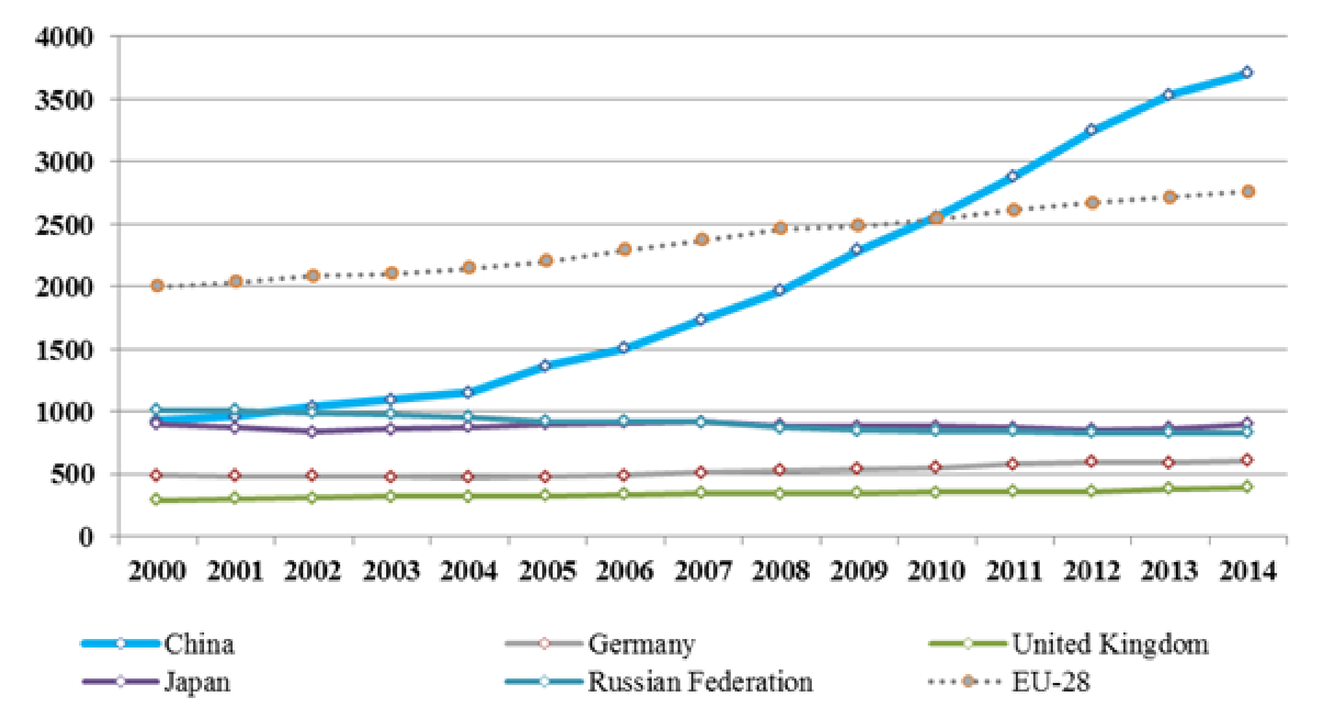
Exhibit 4 R&D intensity (GERD, %)



Source: OECD Main Science and Technology Indicators

The Chinese government channeled significant investments to build sufficient base of talents. In terms of the number of R&D personnel, China ranks first in the world, with the number of R&D personnel amounting to over 3.7 million FTEs or approximately one third of the world's total. In the last decade, the number of total R&D personnel increased more than threefold, while other countries demonstrated moderate increase or even decline.

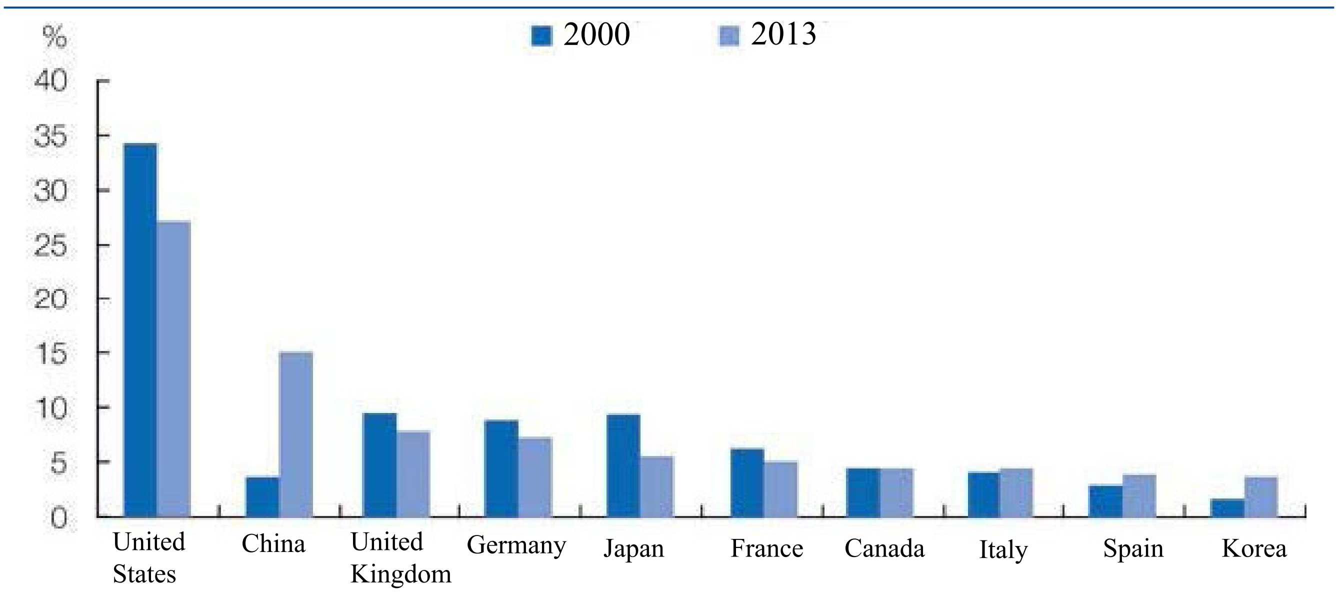
Exhibit 5 R&D personnel (thousand FTEs)



Source: OECD Main Science and Technology Indicators, Chinese Academy of Science and Technology for Development (CASTED)

Increase in the number of researchers translated into remarkable growth of scientific productivity in terms of SCI paper publications. The total number of SCI publications is regarded as a general measure of a country's capacity in knowledge creation, and, to some extent, an indication of innovation capability. Based on the number of scientific papers, Chinese researchers are second only to the United States. In 2013, the total number of China's SCI papers reached up to 213 000, accounting for up to 15 percent of the global total. Moreover, the gap between the United States and China is going to decrease, as China demonstrates an annual growth of over 15 percent in the number of SCI papers, which is the highest in the world.

Exhibit 6 Percentage of SCI Papers in the World's total (2000 and 2013)



Source: National Innovation Index Report 2014, CASTED

In the last decade, the country has demonstrated remarkable increase in the total share of SCI publications. Currently, China ranks the second in the world measured by the total number of SCI papers published in magazines indexed in Web of Science. China's impact, measured by citation ratio, is also increasing. However, China still lags behind the leading countries in terms of quotations per publication.

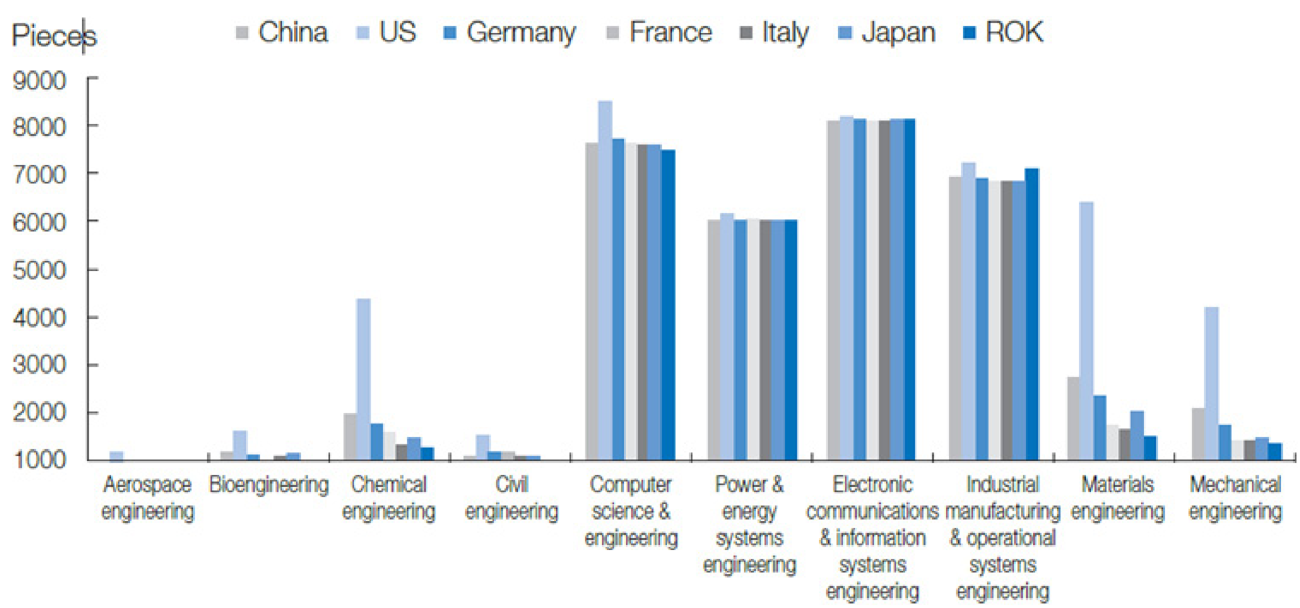
Table 1 SCI Papers and Quotations (Web of Science, 2010 – 2014)

Country	Total number of SCI Papers (WoS) 2010-2014, thousand	Share in the world's total (2014), %	Quotations	Quotations per publication
United States	1 834.0	24.91	14 391.7	7.85
China	963.0	17.55	4 523.0	4.70
United Kingdom	438.4	5.48	3 580.8	8.17
Germany	486.8	6.70	3 742.4	7.69
Japan	387.4	4.99	2 146.6	5.54
Russia	144.3	2.05	437.6	3.03

Source: National Innovation Index Report 2014, CASTED

Analysis of the industry distribution demonstrates that China is in line with developed countries in applied areas, such as computer science and engineering, power and energy systems engineering, electronic communications and information systems, industrial manufacturing and operational systems engineering. At the same time, China's average papers citation in a number of science-based and engineering-based areas is lower than most of the leading countries.

Exhibit 7 Total number of SCI papers in engineering fields



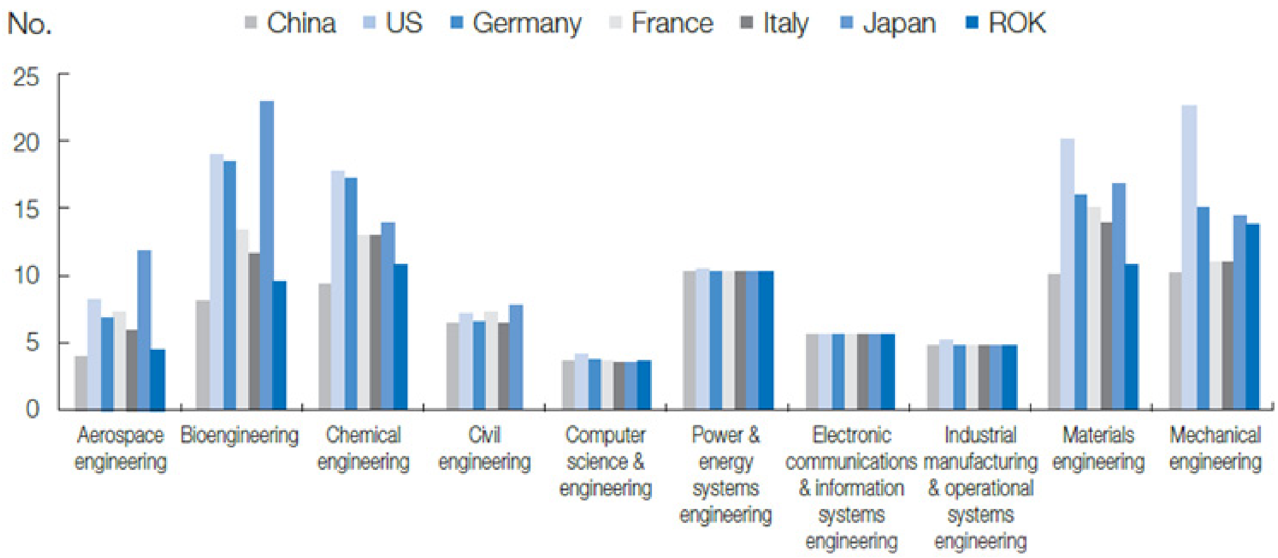
Source: National Innovation Index Report 2013, CASTED

Number of patent applications and patent awards are considered among the general metrics of innovation prowess and knowledge creation. In 2013, China's domestic patent applications reached 705 000 units, accounting for up to 44 percent of the 40 countries, ranking first globally for a consecutive four years[2]. The quantity of domestic patents issued reached up to 144 000 units, accounting for up to 21.4 percent of the total for 40 countries, second only to Japan[3].

[2] *WIPO, Statistical Country Profiles*

[3] *WIPO, Statistical Country Profiles*

Exhibit 8 Total number of SCI papers of certain countries in different engineering fields



Source: National Innovation Index Report 2013, CASTED

Table 2 Number of applications and grants of domestic patents (2000 and 2014)

Country	Number of domestic patent applications and world's rank		Number of grants and world's rank	
	2000	2014	2000	2014
United States	164 795 (2)	285 096 (2)	85 071 (2)	144 621 (3)
China	25 346 (6)	801 135 (1)	6 177 (7)	162 680 (2)
United Kingdom	26 409 (5)	19 922 (8)	4 380 (10)	4 388 (9)
Germany	71 840 (4)	73 826 (5)	17 167 (4)	23 714 (5)
Japan	384 201 (1)	265 959 (3)	112 269 (1)	177 750 (1)
Russia	23 377 (7)	24 370 (7)	14 444 (5)	23 305 (6)

Source: WIPO, Statistical Country Profiles

Patents which are filed in the United States, Japan and with the European Patent Office are called triadic patents. Number of triadic patents could be used as a proxy for quality and willingness to expand internationally. China has demonstrated miraculous growth in total number of triadic patent families, however still only a small portion of Chinese patents filed in 2013 were triadic. Total numbers of triadic patent families in China and United Kingdom in 2013 are nearly equal, while total number of Chinese domestic patent applications is nearly 37 times greater.

Table 3 Number of triadic patents

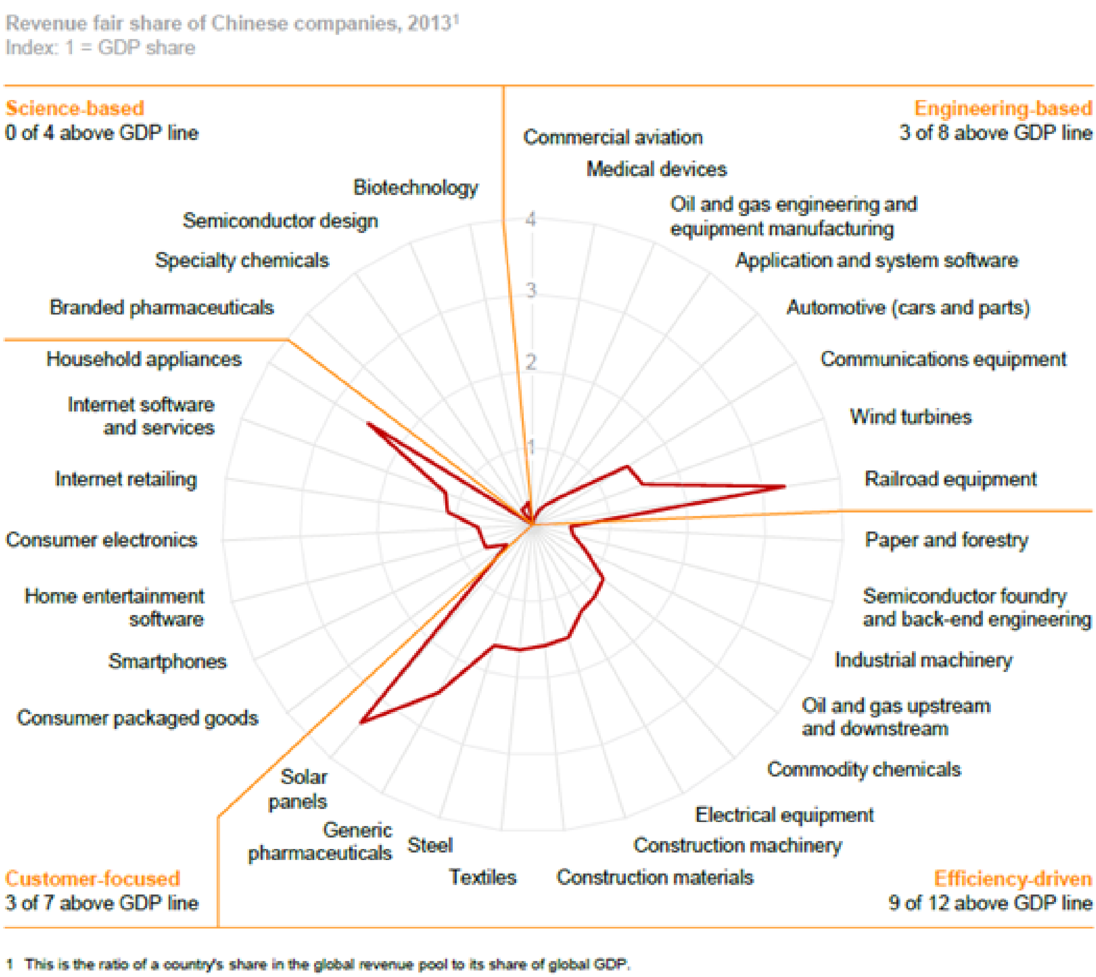
Country	Number of triadic patent families (2000)	Number of triadic patent families (2013)
United States	15 625	14 211
China	87	1 897
United Kingdom	2 362	1 726
Germany	7 637	5 525
Japan	17 915	16 197

Source: OECD Main Science and Technology Indicators

In order to be efficient, an innovation system should provide mechanisms which connect knowledge-creation to commercialization. Based on the McKinsey's research, the proof of successful innovation on the micro-level is the ability to expand revenue and raise profits with new products and services, as well as improvements in design, manufacturing, or business models.

The diagram indicates that, measured by relative market share, Chinese companies show the greatest strengths in markets that require customer-focused and efficiency driven innovation. Based on the McKinsey's results, industries belonging to the efficiency-driven innovation archetype form the China's innovation domain. Solar panels, generic pharmaceuticals, textiles and metals are the industries with the strongest presence of Chinese companies. It is quite natural, taking into consideration developed infrastructure of high-tech industrial parks and zones, and vast ecosystem of suppliers, which is the core of China's competitive advantage.

Exhibit 9 Revenue fair share of Chinese companies, 2013



Source: China's Effect on Global Innovation, McKinsey Global Institute Report

The analysis is based on gauging the share China's companies occupy on global markets in several industries. The authors used a proprietary database of more than 20,000 publicly held companies from around the world as a basis for the quantitative analysis.

Consumer-focused industries form the second strong area of Chinese companies, which can be easily explained, looking at the huge and sophisticated market of the country. Local producers enjoy excellent competitive advantages by learning consumer insights and satisfying the unmet needs. It is important to note that some of China's niche markets exceed the markets of average European countries, which provide great opportunities for growth and development.

As we describe later in the report, the success in efficiency-driven and customer-focused innovation was majorly predetermined by the targeted state policy for innovation development. Since "Reforms and Open-Up" policy was proclaimed, the government is gradually building the innovation and manufacturing infrastructure, fostering absorption of foreign investment and technologies. While maturing, China's national innovation ecosystem is transforming from the innovative sponge to self-propelling state. Enterprises tend to play greater role in R&D activities, shifting focus to more advanced stages.

At the same time, China has to do a lot in industries that rely on science-based and engineering-based innovation. Basing on the McKinsey report, China has less than 1 percent share of global revenue in branded pharmaceuticals, and 3 percent in each of the other three: biotech, semiconductor design, and specialty chemicals.

Long term business cycle is the key impediment to rapid development and transformation of science-based and engineering based industries. Reforms initiated by the state in 1980s – 1990s have already resulted in remarkable growth in number of publications and patenting activities; however the commercialization results have yet to be achieved. However, the rail-road equipment industry demonstrates the success story of taking leadership on the global market, where China has over 40 percent of global revenue and is considered the biggest global producer of high-speed trains. As we have previously stated, the success path among types of innovations greatly relies on the targeted government support. China's government programs, institutional reforms and heavy investments in education provided a large supply of skilled scientists and researchers. The government helps to develop the domestic market for high-tech products by purchasing programs that foster local demand and by stimulating knowledge and technology transfer with foreign partners.

CHINA'S POLICIES ON INNOVATION DEVELOPMENT

China has sustained high rate of innovation development over recent decades and managed to transform the economy from the manufacturing towards one of the innovation centers of the world. The success of China's innovation development would be impossible without targeted government support. The state has been fostering innovation development for over three decades, through combination of economic and industrial policies and heavy investments in educational and research infrastructure. This support has helped China develop a solid background in certain industries and provided the national innovation system with sufficient talents and institutional mechanisms to achieve the challenging innovation targets.

It is important to notice, that development of the national innovation system was supported by reforms of the Chinese economic system in general. Transformation of the economy towards innovation-based model was synchronized with introduction of market-based mechanisms, attraction of foreign investments, technological transfer and gradual development of internal markets for innovation products and services.

Initiation of reforms (1978 – 1985)

The spring of 1978 is known as "the Spring of Science" as it opened the process of innovation development and reforming of science and technologies in China. The National Science Conference which took place in Beijing in March 1978 announced the government policy of encouragement of science and technology. During the Conference, Deng Xiaoping proposed the thesis that "science and technology is productivity", removing political barriers to the scientific and technological development after ten years of chaos, which laid a foundation for the establishment of the strategy of reinvigorating the nation through science and education and the strategy of strengthening the nation through human resource development. The conference deliberated and approved the "Outline National Plan for the Development of Science and Technology 1978-1985 (draft) which became a road-map for transforming the S&T system in China.

The Plan established the 8-year objectives of Chinese scientific and technological development including a target of 800,000 professional researchers and building a national scientific and technological research system. The Plan also marked 108 projects as key projects of national scientific and technological research (which were adjusted to 38 national research projects in 1982). It also required that the 8 comprehensive scientific and technological fields of agriculture, energy, materials, computers, laser, space, high energy physics and genetic engineering be placed in a prominent position, with greater efforts needed to realize significant achievements so as to promote the high-speed development of the whole science and technology and the whole national economy.

Along with the revitalization of S&T sector, China's economic system faced beginning of deep transformation and liberalization marked by implementation of the "Reforms and Opening Up" policy. The new policy encompassed a number of institutional reforms as well as government infrastructure programs. The new course was announced in December 1978 at the 3d Plenary Session of the 11th Central Committee of the Communist Party of China, this event is widely considered as the turning point in post-1949 Chinese history, marking the initiation of the nationwide economic reforms. The first stage of the reforms which were carried out in the late 1970s and early 1980s, involved the opening up of the country to foreign investment and providing permissions for entrepreneurs to start businesses.

The institutional reforms were accompanied by organizational changes aimed at development of industrial infrastructure and fostering economic cooperation through establishment of first special economic zones and open coastal cities and areas, and designating inland and coastal economic and technology development zones. In August 1980, the National People's Congress (NPC) passed "Regulations for the Special Economy Zone". First zones were launched in Shenzhen, Zhuhai and Shantou in Guangdong, Xiamen in Fujian, as well as designation of the entire Hainan province as a special economic zone. At the initial stage economic zones were focused on development of a solid background for industrial development, including development of facilities and infrastructure as well as transfer of technologies.

The six year period till 1984 was marked by the creation of spin-offs from the public research organizations (PROs) to commercialize research results and cover the gap between research and industry implementation. Lenovo (formerly Legend) and Founder of Peking University became later recognized successes of China's information technology industry.

The government also focused on developing the human capital. These measures included the transformation of schools and higher education in order to introduce links between education and the market as well as promote scientific exchange with the United States and other developed countries.

Structural reform of the S&T system

After the initial stage of the transformation, deeper institutional reforms of the Chinese S&T system were launched in 1985, following the government's decision to reform the economic system. This move was accompanied by the second stage of the "Reforms and Opening Up" policy which involved the privatization and contracting out of much state-owned industry and further implementation of free-market mechanisms.

The key structural problem of Chinese science and technology system was the gap between R&D and industrial activities, hindering innovation development. The reforms were aimed at closing this gap and focused on the following measures:

• Implementing of allocation mechanisms for public R&D funding.

• Transformation of R&D institutions in applied research into business entities and / or technical service organizations, and the incorporation of large R&D institutions into large enterprises.

• Creation of markets for technology.

• Reform of the management of human resources in public research institutions.

These reforms introduced market mechanisms and practices of competition which refocused Chinese S&T system to be more economy-oriented. As well as changing the focus of the S&T system the government improved governance mechanisms and implemented a number of targeted programs to enhance China's internal research and innovation capabilities. The programs were also intended on creating markets for advanced technologies. As a result, public research organizations increased reliance on non-government financing and engaged in research projects for the enterprise sector.

State programs as instruments of development

The 1980s was marked by a series of state programs with the strategic aim of developing China's competitiveness in science and technology. The Key Technologies and R&D, the 863 Program and 973 Program have formed the solid background for science and technology development. Later on, followed the Spark and the Torch programs.

The Key Technologies R&D programs was launched in 1982, it was the first and one of the biggest technological programs in China of the 20th century. The program covered a whole range of fields, including agriculture, environmental protection, medical and health care.

In March 1986, China began to implement the "Advanced Technology Research Development Plan" (863 Plan) designed to develop the internal capabilities for innovation in the breakthrough areas. The "863 Plan" was proposed by engineers Wang Ganchang, Wang Daheng, Yang Jiaxi, and Chen Fangyun in a letter to the government and endorsed by Deng Xiaoping. Implementation of the Program started during the Seventh Five-Year, the program continued to operate through the two five-year plans that followed, with state financing of around 11 billion RMB and resulted in obtaining 2000 patents (national and international). The Program set 20 fields in biology, space flight, information technologies and telecommunications, lasers, automation, energy and new materials. In 1996, the program was enhanced by adding a new field of Marine Technology. The set of program fields is decided by scientists after discussion, and specific projects are decided by an expert committee.

The 973 Program was designed as a China's key program for development of basic scientific research. The Program was launched in 1998 and involved multi-disciplinary, comprehensive research on important scientific issues in agriculture, energy, information technologies, environment of resources, health care, and materials, providing competencies for science-based type of innovation development.

The Torch Program was launched in August 1988 as China's major hi-tech industry program and a national roadmap. It included development of hi-tech industrial development zones throughout the country, and involved projects in new technology fields, such as new materials, biotechnology, electronic information, integrated mechanical-electrical technology, and advanced and energy-saving technology. The Spark Program was intended to revitalize rural economy through development of high-technology projects. In 1988, the Chinese government successively approved the founding of 53 national high-tech industrial development zones.

Shift to a firm-centered model and development of knowledge-creation capablities

In 1995, the Chinese government launched the "revitalizing the nation through science and education strategy". The strategy was intended to institutionalize innovation development achieved by the programs (Spark, Torch, etc.) and aimed to increase China's competitiveness in the global knowledge economy in view of entering the World Trade Organization.

The strategy actions were focused on engineering and building an enterprise-centered innovation system, strengthening firms' innovation capabilities and commercialization of technology. Institutional reforms included deployment of the Knowledge Exchange Program of the Chinese Academy of Science and implementing best practices on innovation management from OECD countries.

The policy document of this stage was promulgated at the 1995 National Conference on Science and Technology and was known as the "Decisions on Enhancing Scientific and Technological Progress by the CCCPC and State Council". The document stressed that China had to establish a new development strategy, must rely on the progress of science and technology and needed to improve the scientific and cultural quality of the entire nation.

The current strategy document - The National Medium and Long-Term Program for Science and Technology Development (2006 - 2020) was adopted at the 2006 National Science and Innovation Conference. The State Council Leadership Group of 2,000 scientific and technological, education, economic and enterprise experts took three years to prepare the Plan. The plan proposed a policy of scientific and technological work of "Independent Innovation, Critical Progress, Support of Development, and Leadership for the Future", and making overall planning and deployment of the scientific and technological development of China.

In 2012, the Eighteenth Congress of the Communist Party was held, which clearly proposed to "implement the innovation-driven development strategy", and stressed that "scientific and technological innovation is a strategic support to increase social productive sources and overall national strength, so it must be put in the core place of the overall situation of national development". In July 2012, the Party Central Committee and State Council promulgated its Opinions on Deepening Reform of the Science and Technology System and Accelerating the Construction of National Innovation System (abbreviated as Opinions), and held national science and technology innovation conference. This scientific and technological system reform took "enhancing the principal position of enterprise technology innovation, and promoting the close integration between science and economy" as its central task in relation to China's scientific and technological innovation reform and national innovation system construction in a certain period in the future.

Thus, in January 2013, the State Council promulgated Opinions on Enhancing the Principal Position of Enterprise Technology Innovation and Promoting Enterprise Innovation Capability, clearly noted to focus on thoroughly implementing the national technology innovation project to promote the 12 key tasks and corresponding policy measures of enterprise technology innovation.

In 2014, the State Council promulgated its Opinions on Accelerating the Development of Science and Technology Service Industry, formulated the plan for nurturing and expanding science and technology service market, innovative science and technology service model, extending science and technology service chains, promoting the professionalism, networking, large-scale and international development of the science and technology service industry, and providing important guarantees for building an innovative nation and creating an updated version of the Chinese economy. The Opinions proclaimed the strategy of focusing on the development of the 9 tasks including technological transformation services, science and technology consultation service, science and technology finance services; formulated a plan of the 7 policies and measures of completing market mechanism, enhancing fundamental supports, increasing fiscal and taxation supports, expanding capital channels, strengthening personal training, deepening opening up and cooperation, and promoting demonstration application; strived to realize the scale of 8 trillion RMB (1.2 trillion USD) in the science and technology service industry in 2020 so that it will become a critical link to promote the integration between science and technology and economy and an important engine to improve the quality and increase the productivity of economy.

These policies were followed by further development of infrastructure and promotion of entrepreneurship activities aimed at grassroots innovation ("Mass Entrepreneurship, Universal Innovation").

Mass entrepreneurship, Universal innovation

At the 2014 Summer Davos in Tianjin, China's Premier Li Keqiang proposed a new policy called "Mass Entrepreneurship, Universal Innovation". The policy is considered a new engine for China's economic growth. The policy focuses on developing "twin engines" – the engine of mass entrepreneurship and innovation and the engine of improved public goods and services. The State Council, the National Development and Reform Commission and the Ministry of Science and Technology (MOST) amongst other authorities have developed a set of policies and supportive measures including financing, policy guarantees, as well as fiscal and taxation benefits.

Firstly, the government and related bodies are developing and optimizing their financial policies to support entrepreneurship and innovation. The measures include development of investment funds and various fiscal benefits and subsidies. On August 6, 2015, the State Council officially approved the National Development and Reform Commission and the Ministry of Finance to establish national entrepreneurship investment funds to promote entrepreneurship innovation and industry upgrading. As of the end of 2015, over 10.5 billion yuan was contributed to over 200 entrepreneurship investment funds, which covered 26 provinces and cities all over the nation. The state owned enterprises supervised by the SASAC[4] are to set up or make investments in 179 funds, with total capital of over 160 billion yuan. The Ministry of Finance, together with the State Administration of Taxation and other institutions, adopted a set of fiscal benefits, including prolonged VAT and business tax exemption limits, accelerated depreciation of fixed asset and deduction of R&D expenses policies. The set of supportive policies also included entrepreneurship guarantee loans and discounted interest rates and subsidies.

Secondly, China's government is focusing on development of a multi-layer capital market. The measures included development of local capital markets and encouraging access of high-tech companies to specialized stock exchanges under the growth enterprise market (GEM) category. Financial institutions are encouraged to develop special offers for startups firms. The government will also provide support to the development of Internet finance companies and crowd-funded projects.

Thirdly, the government is developing institutional mechanisms to facilitate mass entrepreneurship and innovation. The support measures aim at creating a better environment, improving service infrastructure and fostering knowledge exchange. The network of demonstration bases is being developed to create a service platform for SME and to deepen education and technological reform. The bases would facilitate commercialization and implementation of new technologies. The pilot project included 28 bases which will be completed by 2018.

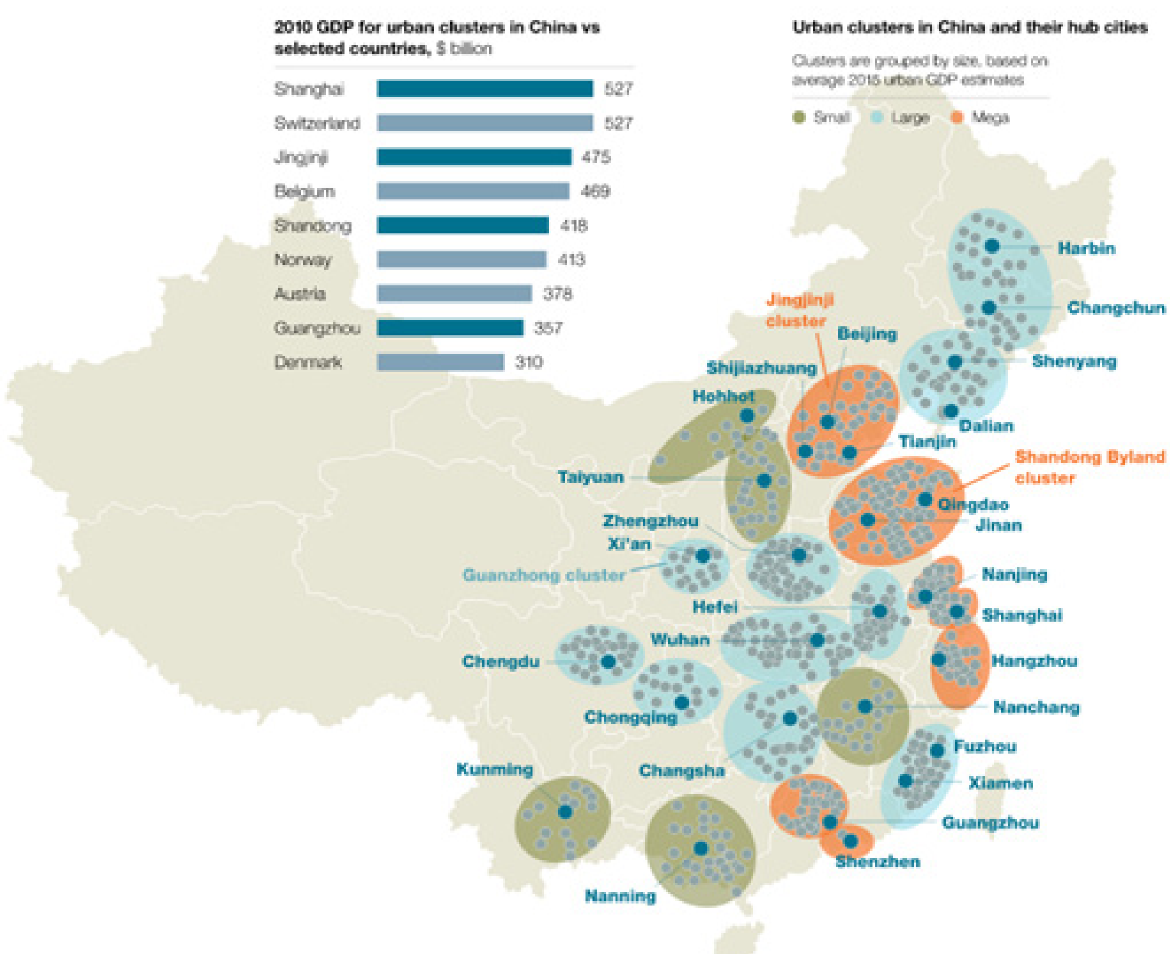
And finally, the reform of education system proposes implementation of innovative training mechanisms and enhancing curriculum to include courses on innovation and entrepreneurship.

[4] *The State-owned Assets Supervision and Administration Commission of the State Council (SASAC)*

CHINA'S INNOVATION INFRASTRUCTURE: SPECIAL ECONOMIC ZONES AND HIGH-TECH ZONES

Thirty or even twenty years ago, Chinese economy was classified as developing and China's innovation infrastructure was simply nonexistent. Nowadays, China is a country that can boast a developed industrial and innovation infrastructure with high-level of specialization. After years of rapid growth, Chinese provinces turned into economic centers with a wide range of industries, production specialization and significant discrepancies. Effect of development policies and impact of special economic zones and technology parks can clearly seen on the industrial map of China. Moreover, some industrial and innovative clusters in terms of GDP are currently equal or exceed in size some countries. That is why we start analysis of Chinese innovation infrastructure from a brief review of China's regional GDP and industrial composition.

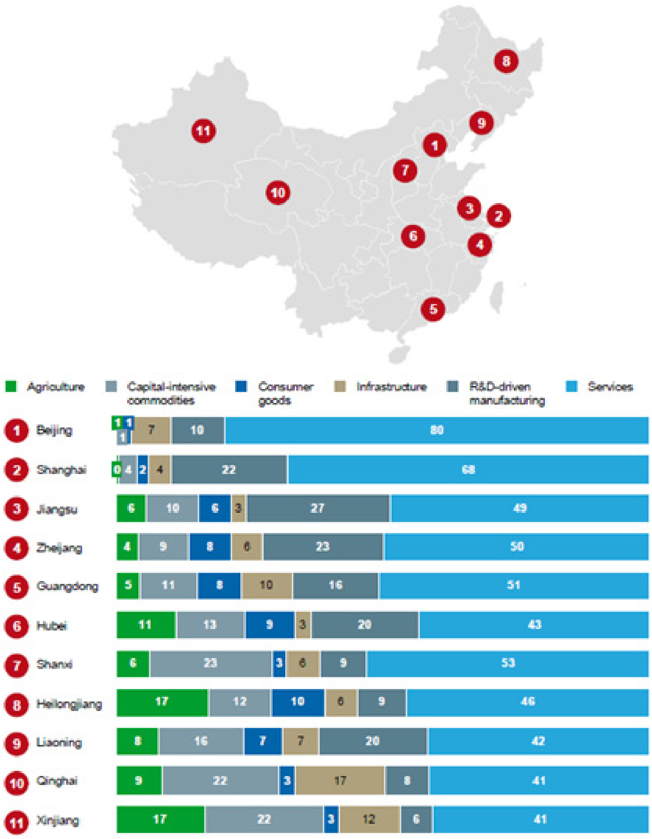
Exhibit 10 Chinese urban clusters' GDP vs selected countries



Source: Winning the $30 trillion decathlon: Going for gold in emerging markets, McKinsey Quarterly, August 2012

The map of Chinese industrial clusters demonstrates that there are a number of high-developed urban clusters, mainly located on China's east-coast. Analysis of the industry allocation indicates that the most advanced urban clusters also have the highest proportion of high-tech industries and greatest level of innovation capabilities.

Exhibit 11 Industry allocation by region in China

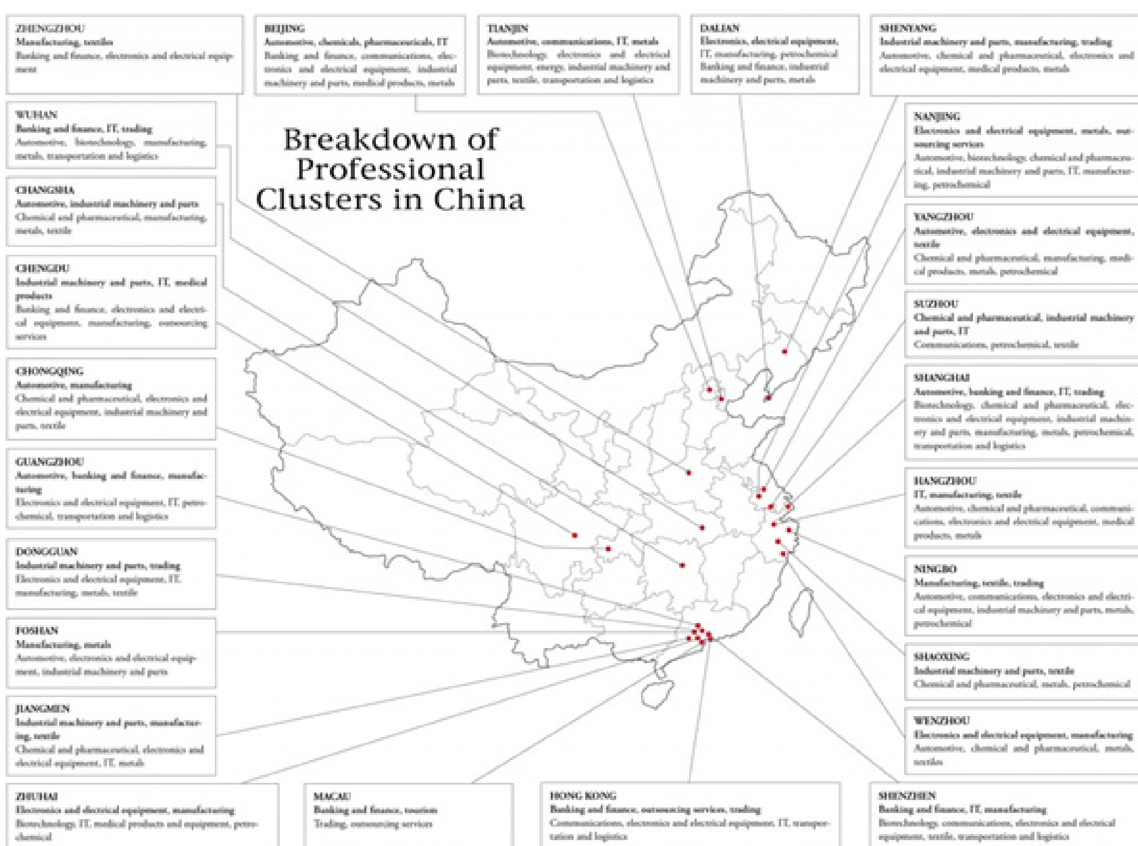


Source: China's choice: capturing the $5 trillion productivity opportunity, McKinsey Global Institute

These regions are also home to the majority of China's Special Economic Zones and High-tech industrial parks. China's government gradually developed capabilities of these areas to make them gateways for technology transfer and centers for industrial production and later transform into centers for knowledge-creation.

China's clusters have distinctive industrial specialization which allows them fully utilize economy of scale and competitive advantages of access to high-qualified local labor force.

Exhibit 12 Professional specialization of China's clusters



Source: China's briefing, Dezan Shira & Associates

Special economic zones

China's special economic zones (SEZs) are specific regions which adopted more open and flexible special policies than those of other domestic regions in foreign economic activities. The SEZs were developed in fulfillment of the "Reforms and Opening Up" policy, initiated in 1978 and since then have played a remarkable role in promoting China's economic growth, institutional reforms and connectivity to the global economy. The first wave of special economic zones built a foundation for experimenting with the introduction of elements of controlled markets in a centrally planned economy, implementing free-trade and investment regime into an economy that was largely closed since 1949. It was the special economic zones that created a background for rapid development of high-tech science parks and high-tech zones in China.

In July 1979, the CPC Central Committee and the State Council issued the Regulation on Special Export Zones in Guangdong Province to approve the establishment of special economic zones. The first SEZs were created in coastal towns of Shenzhen, Zhuhai, Shantou and Xiamen. Following this, 14 coastal port cities and Hainan Island enjoyed the special economic regime. In the next years, several types of special zones have mushroomed across China.

Exhibit 13 Map of China's SEZs

Source: Experience relating to the construction of science parks and special economic zones in China, TusPark and Tsinghua University

In 2014, China has six special economic zones, including Shenzhen, Zhuhai, Shantou, Xiamen, Nanhai, and Kashgar, 14 open coastal cities, 4 pilot free trade areas and five financial reform pilot area. There were also more than 110 national high-tech development parks, and 164 national agricultural technology parks. Based on the WorldBank's research[5] national SEZs have contributed over 20 percent of China's GDP, 45 percent of total national foreign direct investment, and 60 percent of exports.

High-tech science parks and high-tech zones

China's technology parks represent the backbone of the research infrastructure. They have mainly emerged on the basis of special economic zones and played a crucial role in fostering innovation development of China. The industrial parks and special zones acted like entry gates for technology transfer and accumulation of investments, as well as catalyst centers forming regional markets for goods and services.

By now, national high-tech zones have developed into an important reliable source of innovation-driven development and many high-tech zones have become the important support of regional and local economy. The output value of high-tech zones accounted for 10 percent of China's GDP. In 2014, the total revenue of the high-tech clusters accounted for RMB 20.3 trillion and added value exceeded RMB 5.8 trillion[6]. The high-tech clusters turned into the drivers of

[5] *China's Special Economic Zones, www.worldbank.org*

[6] *Experience Relating to the Construction of Science Parks and Special Economic Zones in China, TusPark and Tsinghua University*

regional economy, demonstrating a remarkable revenue growth rate of 20% for many consecutive years. Its contribution to the regional and urban economic development is growing even faster. In 2014, there were 46 high-tech zones with industrial added value accounting for more than 30% in the cities, and there were 35 high-tech zones with the GDP accounting for more than 20% of the GDP of the local cities.

After more than 20 years of learning, accumulation and improvement, China's high-tech zones have improved the position of China's industries on the global value chain. In 2014, the enterprises in high-tech zones had 53,895 valid patents including 16,020 invention patent grants, respectively accounting for 7.4% and 11.3% of China's total quantity. In 2014, the average industrial output value per capita of national high-tech zones was RMB 780k (approximately $117k)[7].

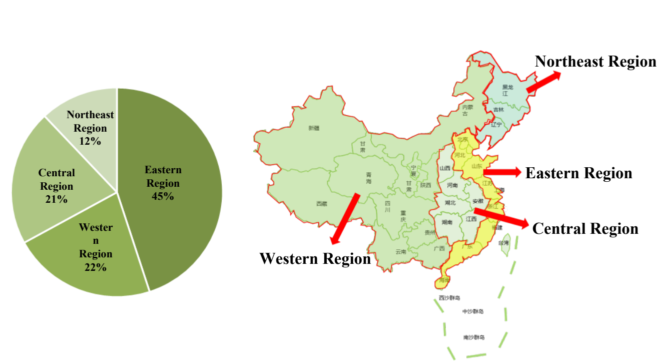
At present, 25 high-tech export-oriented production bases including Beijing Zhongguancun Science Park have been established in national high-tech zones. The export bases were the place, where many China's leading innovative companies have emerged, including Lenovo, Huawei, ZTE, Haier, Datang.

China's high-tech zones demonstrate high efficiency in terms of resource usage. In 2014, the industrial added value per capita was RMB 200,000 per person, which was 5.7 times higher of that of the whole country. The energy consumption per RMB 10,000 of GDP of the high-tech zones was 0.2t – 0.4t of standard coal, which was just 1/5 to 1/3 of the national average level. To illustrate the gap, China's average energy consumption is 1.1t standard coal[8].

High-tech zones have created environment which facilitated dissemination and implementation of best practices on technology enterprises. In 2014, enterprises in high-tech zones participated in more than 180,000 science and technology projects. Among 53,692 enterprises, there have been 783 listed enterprises including 489 high-tech enterprises recognized based on new standards, accounting for 62.5% of total quantity of listed enterprises[9]. The high-tech zones have formed solid background in advanced industries and have become an important force for optimizing industrial structures and promoting the transformation of economic growth models.

As of June 2015, China's 129 high-tech science parks have been mostly established in the intelligence-intensive large and medium-sized cities and the coastal cities with better conditions for opening up.

Exhibit 14 Distribution of State-level High-Tech Science Parks in China



Source: China's choice: capturing the $5 trillion productivity opportunity, McKinsey Global Institute

High-tech zones are primarily concentrated in North China, Eastern China and southeastern coastal regions with relatively developed economies, especially in the coastal belts of these regions, such as Beijing, Tianjin, Jiangsu, Shandong, Guangdong, Shanghai and Fujian. There are 58 high-tech zones in Eastern Region, 27 high-tech zones in the Central Region, 29 high-tech zones in the Western Region and 15 high-tech zones in the Northeast Region.

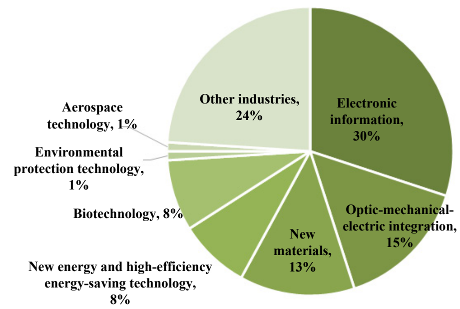
In the ten years from 1978 to 1988, the economic growth of these regions was promoted primarily through deregulating the market and facilitating the flow of investments from the state and foreign partners. During that period a large number of export-oriented labor-intensive enterprises were established. After the 1990s, the vigorous development of high-tech zones promoted the fundamental transformation of these regions from extensive to intensive pattern, from labor-intensive to technology-intensive and capital-intensive, from export to domestic and foreign demand and from single production to research, development, production and comprehensive services.

[7] Experience Relating to the Construction of Science Parks and Special Economic Zones in China, TusPark and Tsinghua University
[8] Experience Relating to the Construction of Science Parks and Special Economic Zones in China, TusPark and Tsinghua University
[9] Experience Relating to the Construction of Science Parks and Special Economic Zones in China, TusPark and Tsinghua University

Exhibit 15 Distribution of state-level high-tech science parks in China

Source: Experience Relating to the Construction of Science Parks and Special Economic Zones in China, TusPark and Tsinghua University

Exhibit 16 Industry distribution of high-tech science parks

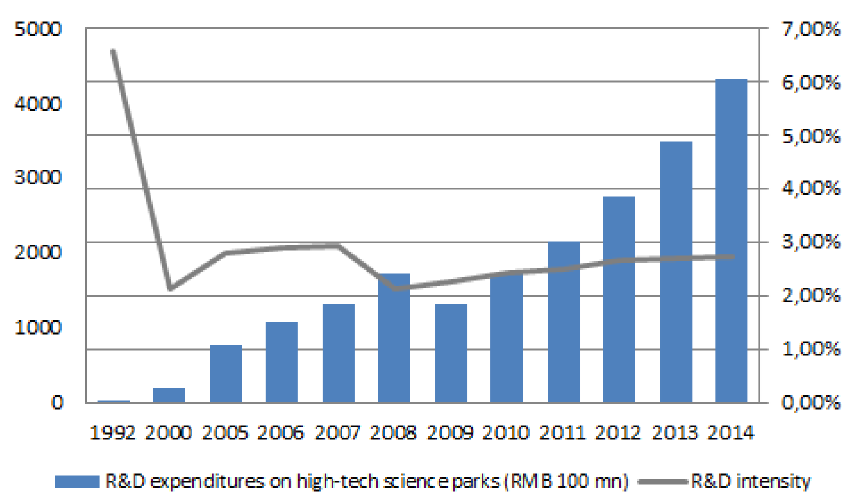


Source: Experience Relating to the Construction of Science Parks and Special Economic Zones in China, TusPark and Tsinghua University

China's industrial zones have become well-known centers of high-tech industries, such as electronics, new materials, biotechnology, renewable energy and energy-saving technologies, environmental protection, aerospace technology. For instance, Zhongguancun information service industry clusters, Zhangjiang integrated circuit industry clusters, Shenzhen communication and software industry clusters, Changchun automobile and parts industry clusters, Chengdu biological medicine industry clusters, Wuhan photoelectron industry clusters, Tianjin green energy industry clusters and other modern industry clusters have been formed or are in the process of being formed.

R&D intensity is a widely-accepted general indicator to gauge the scale of innovation development. In the recent decades, the R&D intensity of the high-tech zones remained above 2 percent. The total R&D expenditures of high-tech zones rose from 1.5 billion RMB in 1992 to 432.5 billion RMB ($64.8 billion) in 2014.

Exhibit 17 R&D expenses and R&D intensity of State-level High-tech Science Parks in China



High level of R&D investments translated into accelerated growth of industrial added value, revenue and net profit of zones. For example, industrial added value in 1992 accounted for RMB 7.1 billion, while in 2014 the total value of industrial added value exceeded RMB 3.6 trillion. The profits of high-tech enterprises increased from RMB 1 billion in 1992 to RMB 1.5 trillion in 2014, with an average annual increase of 38%.

MASS ENTREPRENEURSHIP AND GRASSROOTS INNOVATIONS IN CHINA

Technology parks and high-tech zones which we reviewed in the previous section are well-known elements of the innovation infrastructure. Their rapid development was induced by the state policies aimed at fostering corporate innovation and attracting foreign investment and technologies. The last decade was marked by a new trend of China's SMEs turning into a new source of innovative development. Government policy of "Mass entrepreneurship, Universal innovation" has spurred their activity and called for development of new elements of the Chinese innovation infrastructure, namely business incubators, makerspaces, and new sources of support (business-angels and venture investors) focused primarily on SMEs.

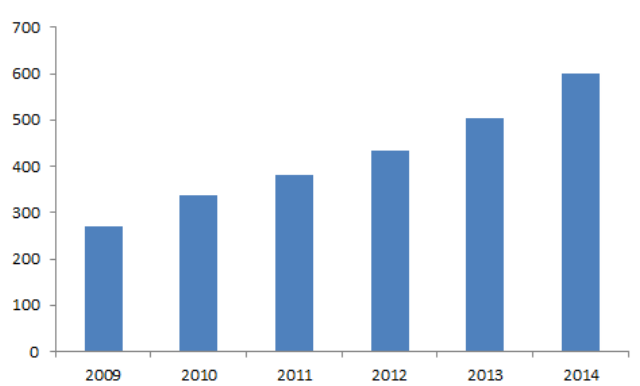
In the past three years, China's newly registered private enterprises have seen a high rate of annual growth of over 21%. In 2015, there were 4.2 million newly registered enterprises, which means that approximately 11 500 new private companies were registered every day. Up to the end of 2015, there were 19.1 million private enterprises (23.4% YoY); the registered capital reached 90.5 trillion RMB (52.9%), total number of employed totaled to 164 million FTEs (13.9% YoY). High-tech companies play a prominent role among the newly established enterprises. In 2015, there were created more than 240 000 IT and software companies (63.9% YoY), more than 73 000 newly registered enterprises in the finance industry (60.7%).

There are still significant regional discrepancies among Chinese provinces. The eastern region is still the core in terms of newly established companies, it accounts for more than half of new enterprises. Beijing and other developed cities enjoyed especially high rates of high-tech start-ups. From January to September 2015, there were 18 000 science-and-technology enterprises in Beijing, a YoY growth of 25% and there were over 10 000 high-tech enterprises in the whole city, taking up 20% of the whole nation. In Hangzhou, there were 468 000 new enterprises, a YoY growth of 20.9%. Newly established enterprises in Shanghai, Wuhan, Chengdu, Xi'an and other cities also took on the trend of significant growth. The growth in entrepreneurial activities is supported by the targeted measures and development of market infrastructure.

Booming Development of Business Incubators and Makerspaces

Development of mass innovation is impossible without appropriate infrastructure and facilities including business incubators and makerspaces. Based on the statistics of the Torch Center of the Ministry of Science and Technology, in 2014 there were 1748 science and technology incubators, 601 national incubators, 1147 non-national incubators, approximately 79 000 incubating enterprises.

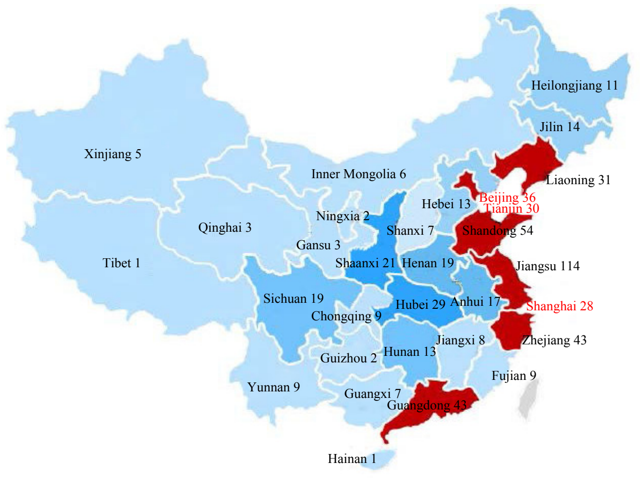
Exhibit 18 National Incubators: total number



Source: Profile of China's Innovation and Entrepreneurship, TusPark

China's national business incubators have a clear regional distribution reflecting the level of innovative development of the Chinese provinces. The majority of incubators are located in the south-east coastal area with leading economic level and abundant business opportunities. Beijing, Shanghai, Tianjin and Guangdong are the most important four provinces and cities. In addition, a large quantity of technology business incubators also aggregate in Jiangsu, Zhejiang, and Shandong.

Exhibit 19 Distribution of Chines National Technology Business Incubators



Source: Profile of China's Innovation and Entrepreneurship, TusPark

Makerspaces, which are also known as hacker-spaces and Fablabs, can be defined as an open access space (free or paid), with infrastructure and facilities, where anyone can come and make something. The first hackspaces appeared in Europe in the 1990s and soon spread to the US in the early 2000s. In 2001, the network of branded digital fabrication workshops grew out of MIT and gave name to the Fablab network. The first makerspace opened in China in 2010. The adoption of the "Mass Entrepreneurship, Universal Innovation" fused the explosion of spaces across the country, as the government's attention fell on the makerspaces as drivers of mass innovation and entrepreneurship. In early 2015, China's Premier Li Keqiang visited Chaihuo makerspace in Shenzhen and proclaimed the imports of the country's maker movement.

Exhibit 20 China's makerspace movement in numbers

Source: "Made In China", NESTA

Based on the latest NESTA[10] survey, we would like to highlight the following trends in China's maker movement:

1. Chinese economy is maturing, making low-cost and labor-intensive manufacturing less attractive for the local companies. Increased wages mean not only lower competitiveness but also greater capacity of internal market. More affluent and demanding consumers require a greater focus on design and innovation of products. For many enterprises, makerspaces represent the way to channelize the innovative energy of their employees and get competitive advantage in the field of customer-focused innovative industries.
2. China's developed industrial ecosystem provides access to thousands of cheap, open-source electronic components, low cost services and infrastructure which is especially favorable for grassroots innovators and makers.
3. The government is supporting the makerspace movement in order to foster grassroots innovation and entrepreneurship as the driver of the next phase of innovation-led economic growth in China.
4. Makerspaces provide a good way for development of creativity and entrepreneurial skills, which are required under the new approach of "Designed in China" vs previous "Made in China".

[10] *NESTA, "Made in China", http://www.nesta.org.uk/sites/default/files/made_in_china-_makerspaces_report.pdf*

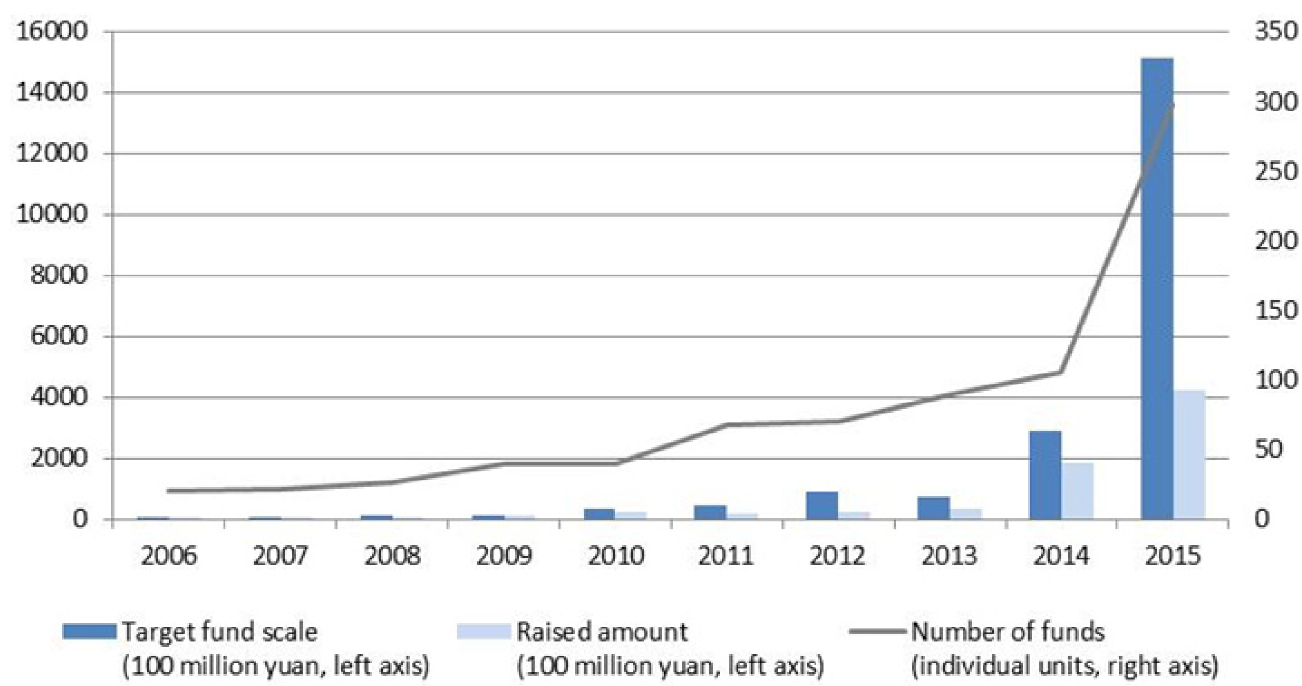
Explosive growth of entrepreneurship financing

In recent years, China's governments at different levels enhanced financial support for entrepreneurship and innovations. With the continuous improvement of sourcing mechanisms, the entrepreneurial innovation financing environment has significantly improved, and enterprise financing channels and methods are becoming more diversified.

Government-backed venture funds

Following the implementation of the "Mass Entrepreneurship, Universal Innovation" policy, substantial efforts were focused on developing a financial background for the entrepreneurship activities. The government is switching from direct support to more market-based instruments, such as government-backed venture funds (government guidance funds) and investment guarantees. As of the end of 2015, China has established 780 government loan funds with the total investment capacity of over 2,180 billion yuan ($330 billion). This amount is almost five times the sum raised by other venture firms last year globally and is considered the biggest investment amount for startups collected in the world, according to London-based consultancy Preqin.

Exhibit 21 Establishment of new government funds



Source: Profile of China's Innovation and Entrepreneurship, TusPark

By developing the government-guided funds infrastructure the government wants to enhance pure market-based mechanisms of allocation of capital and channel investments to seed and early stages start-ups. The rapid development of state funds reflects the explosive growth of private sector in China. According to Bloomberg[11], there are some 15,857 limited partners that have disclosed investments in PE and VC funds totaling 6.1 trillion yuan ($900 billion).

In May 2014, in order to improve governance mechanisms, the executive meeting of the State Council called for establishment and completion of the long-term mechanism of the marketization of the government-backed funds. Later, in January 2015, the executive meeting of the State Council stressed that newly established national emerging investment funds hire professional management companies and use independent investment decision-making through open tendering.

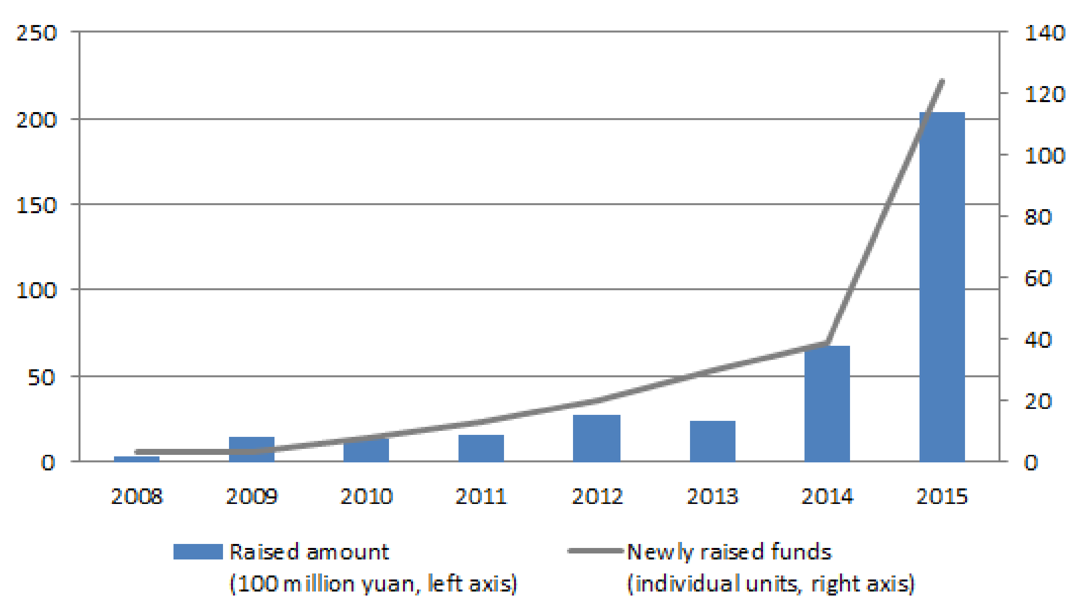
[11] http://www.bloomberg.com/news/articles/2016-03-08/china-state-backed-venture-funds-tripled-to-338-billion-in-2015

Business-angels

The angel investment market is gaining momentum and is starting to play a more prominent role. The rapid growth of angel investment in China can be explained by the number of factors. First of all, decades of extensive growth, especially development of innovative industries such as IT, biotechnology and alternative energy fueled China's population of high net worth individuals. According to the recent survey by Bain and China Merchant Bank[12], the total number of China's high net worth individuals (HNWIs) exceeded 1 million in 2014 – twice that in 2010. China's total private wealth market achieved 16 percent annual growth for 2012 – 2014 and reached 112 trillion renminbi (RMB) in 2014.

Secondly, the Chinese economy has moved to the New Normal state facing declining returns. For decades, as China's economy boomed, local investors had little incentive to work with startups. This fact urged investors to change their strategies and pursue more risk-oriented opportunities. According to the Bain's research, China's HNWIs are adjusting their strategies following domestic reforms. More than one-third (36%) of HNWIs surveyed indicated that they expect to increase their investment in innovative industries such as IT, biotechnology and alternative energy. The accelerated growth of innovative industries is forming a positive feedback loop: it is driving the emergence of a new HNWI which in turn invest in innovative industries. Many entrepreneurs who successfully obtained angel-round or A-round financing also joined in the group of angel investors. China's angel investor market is transforming towards greater institutionalization. In order to improve investing capabilities and diversify risks, many angel investors establish angel investment institutes. Angel investment is gradually changing from individual investments towards large-scale and institutionalized business. As of the end of 2015, there had been 350 Chinese angel investment agencies (with more than 150 active angel agencies), and the capital under management exceeded 60 billion RMB ($9 billion). In 2015, Chinese angel investment raised 124 funds with the total amount of 20.4 billion RMB ($3.1 billion) (Y-o-Y growth of over 200 percent). According to the report by TusPark and Tsinghua University[13], there were 2075 angel investment cases in China in 2015, while the disclosed total investment volume was approximately 10.2 billion RMB ($1.5 billion). Both the scale and case quantity have doubled in comparison to the previous year.

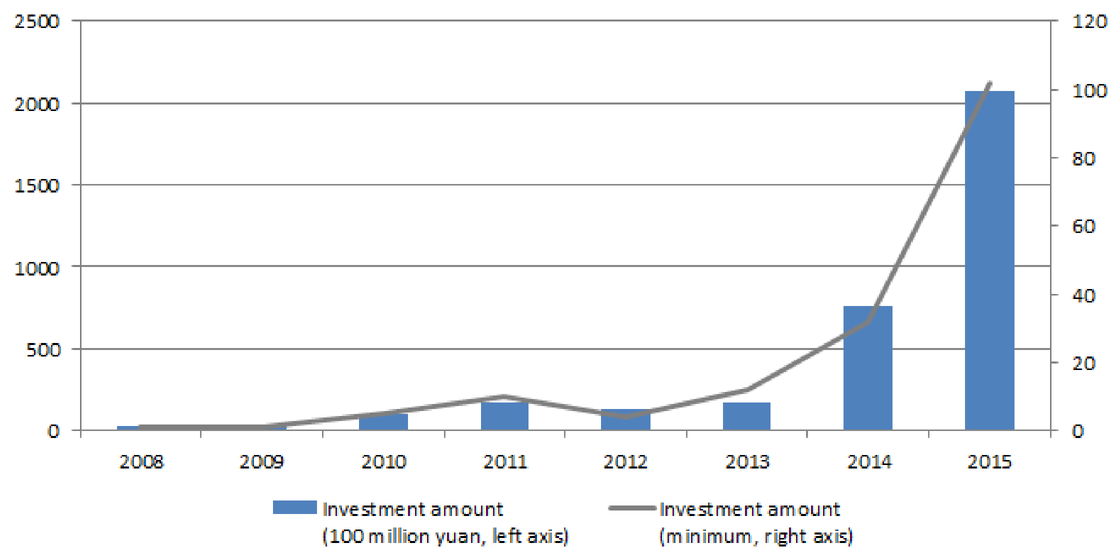
Exhibit 22 Chinese Angel Investors: Fundraising



Source: Profile of China's Innovation and Entrepreneurship, TusPark

[12] *China Private Wealth Report (4th edition)*
[13] *Profile of China's Innovation and Entrepreneurship*

Exhibit 23 Chinese Angel Investors: Investment activities



Source: Profile of China's Innovation and Entrepreneurship, TusPark

According to the research by TusPark and Tsinghua University[14], industries related to IT and telecommunications were the key areas of financing by business-angels, accumulating over 70% of total investment.

Table 4. Chinese Angel Investors: Industrial distribution

Industry	Number of cases	Share in total number, %	Volume	Quotations per publication
Internet	1030	49.64%	51	50.06%
Telecommunication	327	15.76%	13.12	12.88%
Information technology	181	8.72%	9.2	9.03%
Finance	110	5.3%	7.51	7.37%
Entertainment media	61	2.94%	1.7	1.67%
Biological technology/medical care	47	2.27%	3.63	3.56%
Machine manufacturing	32	1.54%	2.34	2.3%
Chain and retail	25	1.20%	1.33	1.31%
Electronic and opto-electronic devices	21	1.01%	0.99	0.97%
Other	241	11.61%	11.06	10.86%
Total	2075	100%	101.88	100%

Source: Profile of China's Innovation and Entrepreneurship, TusPark

Beijing, Shanghai and Shenzhen are the regions with the most active angel investment. Based on the disclosed data, there were over 900 cases in Beijing, accounting for 43.5% of all the disclosed investment cases, involving the investment volume of 4.3 billion RMB ($0.65 billion).

[14] *Profile of China's Innovation and Entrepreneurship*

Table 5. Chinese Angel Investors: top-5 regions

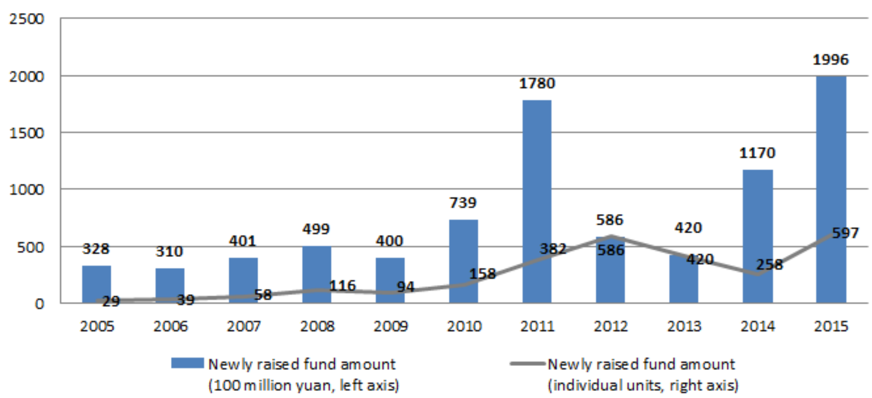
Region	Number of cases	Share in total number, %	Volume	Quotations per publication
Beijing	902	43.47%	43.14	42.61%
Shanghai	341	16.43%	14.89	14.62%
Shenzhen	185	8.92%	9.46	9.29%
Zhejiang	184	8.87%	10.91	10.71%
Guangdong (excluding Shenzhen)	105	5.06%	6.06	5.95%
Sichuan	66	3.18%	2.26	2.22%
Other	292	14.07%	15.16	14.88%
Total	2075	100%	101.88	100%

Source: Profile of China's Innovation and Entrepreneurship, TusPark

Venture Funds

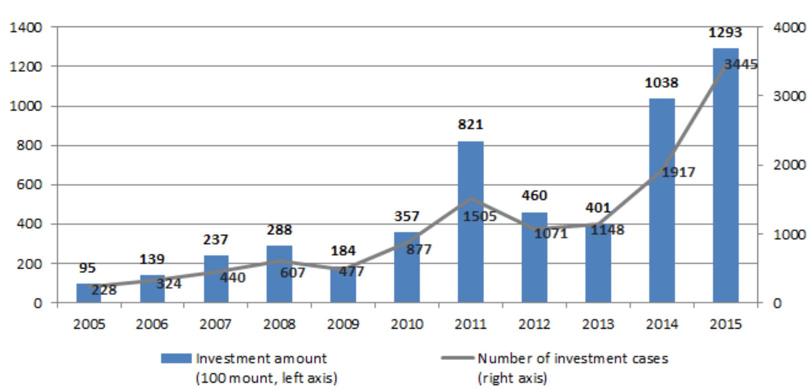
According to the research by TusPark and Tsinghua University , there were over 8,000 active investment agencies, with the assets under management of over 5 trillion RMB ($750 billion). There are more than 2800 venture funds (more than 1000 of them are active), with the assets under management over 1 trillion RMB. In 2015, venture funds launched 597 funds focused on Mainland China with newly attracted capital of 200 billion RMB ($30 billion).

Exhibit 24 Chinese venture funds: fund-raising



Source: Profile of China's Innovation and Entrepreneurship, TusPark

Exhibit 25 Chinese venture funds: investments



Source: Profile of China's Innovation and Entrepreneurship, TusPark

[15] *Profile of China's Innovation and Entrepreneurship*

Key investment focus of Chinese venture funds lies within "Internet+" field, where internet, telecommunications and information technologies accumulate over 50% of total investments.

Table 6. Top-10 industries for venture investments

Industry	Number of cases	Share	Investment (100M RMB)	Share	Average investment volume (100M RMB)
Internet	1051	30.5%	396.94	30.7%	0.43
Telecommunication	481	14.0%	190.13	14.7%	0.46
Information technology	441	12.8%	97.16	7.5%	0.24
Biological technology/ medical care	310	9.0%	143.80	11.1%	0.49
Finance	243	7.1%	120.60	9.3%	0.56
Machine manufacturing	166	4.8%	52.72	4.1%	0.33
Electronic and optoelectronic devices	124	3.6%	41.44	3.2%	0.35
Entertainment media	117	3.4%	41.96	3.2%	0.39
Automobile	22	0.6%	33,86	2.7%	1.00
Retail	39	1.1%	34,42	2.6%	1.56
Other	451	13.1%	140.31	10.9%	
Total	3445	100%	1293.34	100%	0.42

Source: Profile of China's Innovation and Entrepreneurship, TusPark and Tsinghua University

Based on statistics, in 2015, the cases invested in the seed stage took up 22.3% of the venture funds, and the cases invested in the early entrepreneurship stage took up 32.6%, two of which accounted for 54.9% in total, with an increase of 11.5% over that of 2013, reflecting that the venture investors' focus further moved toward the seed stage and early entrepreneurship period, better satisfying the early financing demands of entrepreneurial enterprises. Based on analysis of investment intensity, the average investment volume of the seed stage and the early entrepreneurship stage was respectively 19 million RMB and 35 million RMB, significantly less than the projects of the expansion stage and the mature stage. As a result of the small average investment volume of single project, the projects in the seed stage and early entrepreneurship stage that won the supports of entrepreneurial investment agencies were big in quantity, but small in total investment scale. Based on the measure and calculation of the disclosed amounts, the investment obtained by the two in 2015 took up approximately 37.2% of the total investment volume of the venture investors.

Table 7. Distribution of venture investments by maturity stages

Investment stage	Number of cases	%	Investment finance	Share	Average investment volume (100M RMB)
Seed stage	768	22.3%	129.92	10%	0.19
Early stage	1122	32.6%	352.30	27.2%	0.35
Expansion stage	963	28.0%	412.14	31.9%	0.48
Mature stage	484	14.0%	371.21	28.7%	0.82
Undisclosed	108	3.1%	27.76	2.1%	0.28
Total	3445	100%	1293.34	100%	0.42

Source: Profile of China's Innovation and Entrepreneurship, TusPark and Tsinghua University

The regional distribution of venture investments is still focused on advanced eastern regions. With its policy and resource advantages, Beijing is the most popular city among venture investors. The city accounts for almost 30% of total number and volume of investment cases. The following are Shanghai and Shenzhen, taking approximately 30% together.

Table 8. Top-10 cities by size of venture deals, 2015

Industry	Number of cases	%	Investment (100M RMB)	%	Average investment volume (100M RMB)
Beijing	1042	30.2%	430,93	33.32%	0.47
Shanghai	601	17.4%	257,77	19.93%	0.48
Shenzhen	357	10.4%	131,52	10.17%	0.40
Zhejiang	289	8.4%	99,07	7.66%	0.38
Jiangsu	258	7.5%	96,04	7.43%	0.39
Guangdong (excluding Shenzhen)	228	6.6%	45,79	3.54%	0.22
Hubei	100	2.9%	12,04	0.93%	0.12
Sichuan	84	2.4%	16,92	1.31%	0.21
Fujian	77	2.2%	13,99	1.08%	0.20
Shandong	52	1.5%	12,78	0.99%	0.26
Beijing	1042	30.2%	430,93	33.32%	0.47
Total	3445	100%	1293.34	100%	0.42

Source: Profile of China's Innovation and Entrepreneurship, TusPark and Tsinghua University

PROFILES OF SELECTED CHINESE SCIENCE PARKS AND SPECIAL ECONOMIC ZONES

Tuspark

TusPark (Beijing) is located in the southeast corner of Tsinghua University and the core area of Zhongguancun Science Park, which has a building area of 770,000 square meters and over 400 enterprises and various institutions settling in the park. In the past 20 years since its establishment, TusPark and its branches in various regions of China has accumulatively gathered over 1,000 scientific enterprises and R&D institutions and gradually formed a complete ecosystem composed of a cluster of entrepreneurial high-tech enterprises, a cluster of multinational R&D institutions, a cluster of financial investment institutions, a cluster of intermediary service institutions. TusPark (Beijing) is the university science park with the highest construction speed, the best quality of settled enterprises and the most complete innovation service system in Zhongguancun Science Park and therefore has very high reputation in the international science park industry.

In recent years, TusPark, as a platform of Tsinghua University serving society, has established its branches and innovation bases in Shanghai, Guangzhou, Kunshan, Weihai, and Shenyang through cooperation with local governments so as to accumulate rich experience and resources in the aspects of science park development, operation, management.

Exhibit 26 Image of the TusPark

The development of TusPark saw the following three stages. The first stage which took place from 1994 to 1999 was the construction commencement stage of TusPark. The predecessor of TusHoldings was Beijing TusPark Construction Co., Ltd. which primarily undertook the TusPark creation task and completed the planning and construction of TusPark. The second stage (from 2000 to 2005) was the preliminary forming stage of TusPark which not only completed the construction and investment attraction tasks of TusPark (Beijing) physical space but also gradually established the innovative service system and preliminarily formed the network of branches in China so that TusPark becomes the constructor, manager and operator of science parks. The third stage (from 2006 to present) was the development and perfection stage. TusPark has further strengthened the core competitiveness, further perfected the service system and taken science parks as carriers to form the diversity and integration business architecture covering real estate, investment, service, finance, training, namely the all-in-one business architecture.

Zhongguancun Life Science Park

Founded in 2000, Zhongguancun Life Science Park, as an important part of Zhongguancun Science Park, is a high-tech professional park that gives priority to the research and development innovation of life science research, biotechnology, biological medicine and other relevant fields.

Zhongguancun Life Science Park is located in Changping District, Beijing, which is one of the stations of Beijing Subway Changping Line. This station is located at the west side of Xinzhuang Bridge intersected by Beiqing Road (east-west direction) and Jingzang Expressway (G6, Badaling Expressway, north-south direction) and the southeast side of Zhongguancun Life Science Park and is in the east-west direction. The total planned area of Zhongguancun Life Science Park is 249 hectares. The area of the first-stage project is 130 hectares designed for R&D, pilot testing and as an incubation base with a building area of 540,000 square meters; the area of the second-stage project is 119 hectares planned as the land used for medical service and industrialization.

At present, the park has brought together 7 state-level research institutions including National Engineering Research Center for Beijing Biochip Technology, National Engineering Research Center for Protein Drugs, National Center for “863” Experimental Animals and Pathological Animal Models, 1 medical institution, R&D centers and manufacturing enterprises of 21 famous domestic and foreign enterprises including Yangtze River Pharmaceutical Group, Jiangzhong Pharmaceutical Group, Genzyme Corporation, Syngenta AG, Novo Nordisk, Takara Biomedical Technology, 12 biological medicine service outsourcing enterprises and more than 40 medium and small-sized enterprises of science and technology innovation. There are 85 enterprises in the park, including 18 Sino-foreign joint venture enterprises. According to incomplete statistics, there are 146 domestic and international ongoing projects in the park, and the enterprises in the park have more than 400 patents and 67 technologies for independent intelligent property rights and have undertaken 25 important science and technology projects including national “863” and “973” projects, projects of the National Natural Science Foundation.

Zhanjiang High-Tech Park

Founded in July 1992, Zhanjiang High-Tech Park is located in the middle south of Pudong New District of Shanghai, which is a state-level high-tech park in China and forms the four key development zones of Pudong New District of Shanghai together with Lujiazui, Jinqiao and Waigaoqiao Development Zone. The park is one of the key functional development areas in Pudong with a planning area of 25k square meters, which is divided into technology innovation area, scientific research and education area, high-tech pilot test industry area, living service center area and other functional areas.

As of the end of 2013, the park had 9,164 registered enterprises and 270,000 employees. Moreover, employees with bachelor degree or above accounted for more than 60% of all employees. The total operating revenue of RMB 420 billion was realized with a year-on-year growth of 13.5%. The total industrial output value was RMB 208.4 billion with a year-on-year growth of 19.75%. The fixed-asset investment was RMB 20.6 billion with a year-on-year growth of 1.93%. The tax revenue was RMB 18.915 billion with a year-on-year growth of 10.6%. Therefore, the park has become an important growth column for Pudong’s development.

After 23 years of development, the park has constructed a framework involving the biological medicine innovation chain, IC industry chain and software industry chain. At present, the park has included the State Biotech & Pharmaceutical Industrial Base (Shanghai), National Information Industry Base, National IC Industry Base, National Semiconductor Lighting Industrial Base, National 863 Information Security Achievement Industrialization (Eastern) Base, National Software Industrial Base, National Software Export Base, National Cultural Industry Demonstration Base, National Online Game & Animation Industry Development Base and other state-level bases.

Xiamen Special Economic Zone

Xiamen Special Economic Zone was established in October 1980, as one of China's six special economic zones. It initially comprised a territory of 2.5 sq. km. and in 1984 was expanded to 131 sq. km. to cover the entire Xiamen Island, which comprises Huli District and Siming District excluding Gulangyu. During the start-up stage of its development, the zone faced many difficulties just like other special economic zones in China, such as relatively weak economic foundation, unreasonable industrial structure, weak scientific and technological innovation ability, slow foreign trade development, and weak urban competitiveness. However, after the ten-year start-up stage of construction and development, Xiamen has made substantial development in all respects.

During development stage, which lasted from 1992 to 2000, Xiamen Special Economic Zone demonstrated a rapid development trend. On the basis of constantly summarizing experience in economic development, the government of Xiamen Special Economic Zone actively carried forward the transformation of economic growth model to preliminarily form the layout of comprehensive opening-up layout of the special economic zone, Taiwanese investment zone, bonded area, economic development zone so that the national economy realized the rapid and healthy development and the comprehensive economic strength was markedly enhanced.

In 2001, China's successful entry into the WTO also injected strong impetus into the rapid development of Xiamen Special Economic Zone. The economic aggregate significantly improved and GDP increased from RMB 55.639 billion in 2001 to RMB 206 billion in 2013. The total financial revenue of Xiamen broke through RMB 50 billion, namely RMB 52.6 billion; local financial revenue reached RMB 28.92 billion.

Zhuhai Special Economic Zone

The Zhuhai Special Economic Zone was established on 5 August 1980. Over the years, Zhuhai has consistently adhered to selectively attracting investment and developing characteristic advantaged industries based on its own resource endowments so as to successfully build the pattern of the "4+4+1" characteristic advantaged industries with independent innovation ability and self-development ability. For instance, it has developed and constructed the port and Lingang Industrial Zone through the high quality shoreline resources of Gaolan Port and the natural conditions for the construction of large-scale docks. With the help of special facilities of Zhuhai Airport, it holds the China International Aviation & Aerospace Exhibition and develops the aviation industry. It developed tourism, business affairs, conference exhibition and leisure entertainment through natural scenery and regional advantages of Zhuhai and developed the software industry and other high-tech industries through science and education advantages of Zhuhai.

PART III

RUSSIA'S INNOVATION PROFILE

The role of innovation

As this report is being prepared, the Russian economy is still in the process of a challenging adjustment. After nearly 15 years of growth fueled by high resource prices, that returned Russia to the top list of global economies, growth reversed to a sharp economic turmoil.

The boom turned into depression as the two drivers which supported accelerated growth – significant capital inflow and high resource prices allowed for government expansion faded. Resource prices have almost halved and remain low, significant restrictions are imposed on capital markets and technology transfer with usual counterparts on Western markets.

Since 2014 Russia has been searching for a new approach towards economic growth and trying to unlock the potential of previously underestimated Asian markets. As the previous model of extensive growth is exhausted, Russia must now rely increasingly on internal growth factors, primarily on rising productivity to drive GDP growth. This, then, is Russia's innovation imperative: to raise productivity sufficiently to make up for the loss of momentum from investment and government expansion and gain access to financial resources, technologies and markets through exploring markets of Asian countries.

There is a widely accepted theory that the Russian innovative system is underdeveloped and mainly relies on the government, due to lack of entrepreneurial skills and culture. Is it really true? How innovative is Russia and how innovative does it need to be? What input is required from entrepreneurs and government? These are the fundamental questions underlying the current research. Russia's innovation system is examined through a framework of industry-related innovation archetypes aiming to enhance traditional indicator based approach. The helicopter view is followed by an analysis of the role of the government and actors of the innovation sector, including startups, business sector, research and education institutions as well as venture investors.

Russia's innovation profile

The economic performance and drivers of economic growth, industrial structure and the size of firms as well as the role of the state tend to determine Russian innovation profile of the economy and the innovation performance of the economy.

The Russian economy has long been driven by the resource sector, as Russia's export and balance of payments have been heavily dominated by oil and gas export. Prolonged periods of high prices for natural resources provided limited incentives for development of high-tech industries. The skew towards sectors with low R&D intensity could be illustrated by the composition of GDP by value added.

Table 9. Industry composition of Russia's GDP (added value 2015, %) and R&D intensity[1]

Item	Share in added value, %	R&D intensity[2]
Manufacturing	14%	Low (>1%) and medium-low (1-2%)
Natural resources	10%	Low (>1%)
Transportation and communications	7%	Low (>1%) and medium-low (1-2%)
Construction	6%	Low (>1%)
Agriculture, fishery and forestry	5%	Low (>1%)
Electricity, gas and water generation and transmission	3%	Low (>1%) and medium-low (1-2%)
Housing and utilities	2%	Low (>1%)
Trade, finance, education and other	54%	Low (>1%) and medium-low (1-2%)

Source: Federal Statistical Service

Statistics indicate that sectors with relatively low R&D intensity still occupy high share in the industrial structure measured by added value. For example, the total share of manufacturing and natural resources sector in added value is approximately 25 percent.

The Russian export profile is heavily dominated by the mineral products. Crude oil and natural gas account for over 40 percent of the total export.

Table 10. Russian export, 2014 -2015

Industries	Total	Share in total	Share to 2014
Mineral products	216 101	63%	62%
crude oil	89 576	26%	58%
natural gas	41 844	12%	76%
metals	33 014	10%	82%
Machinery, equipment and means of transport	25 386	7%	96%
Chemical products	25 338	7%	87%
Food and agricultural raw materials	16 181	5%	85%
Wood, pulp and paper products	9 832	3%	84%
Other	50 589	15%	-
Total	3445	100%	69%

Source: Federal Statistical Service

The slump in global commodity prices and decelerating EU growth called for diversification of trade which is currently under way but may take some significant time. Customs data indicate that there are first sights of rebalancing of the trade structure – the value of non-energy exports dropped by approximately 10 – 20 percent while the value of mineral products export plummeted by nearly 40 percent.

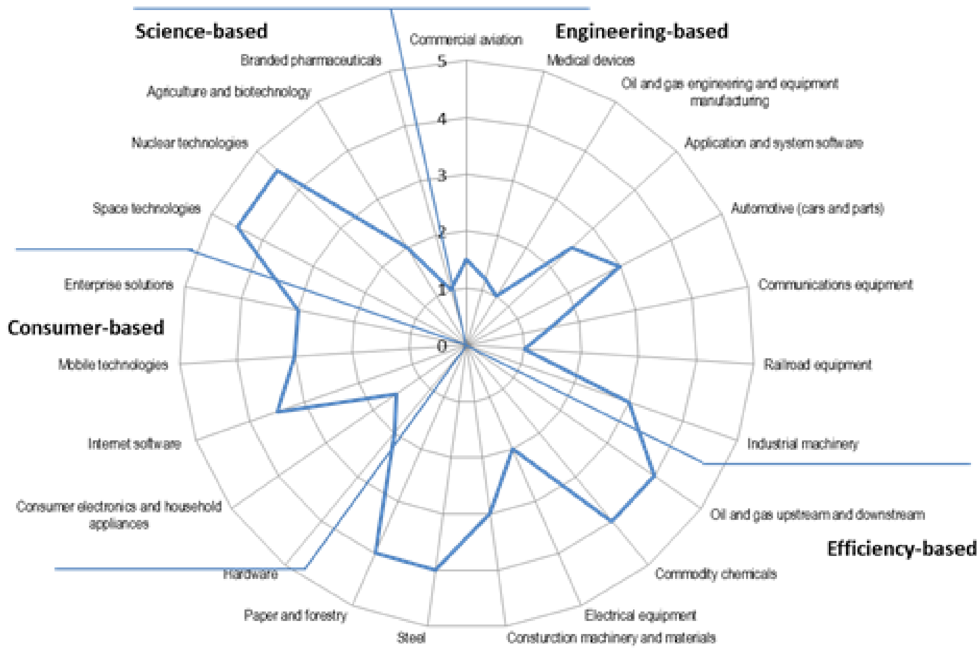
Based on the recent report by the World Bank[3], Russia has periodically launched new export products and attempted to enter new markets, however it struggled to sustain non-resource exports to countries outside its geographic region. Export beyond CIS demonstrated low survival rate as do products outside the country's dominant resource and commodity sectors. On the contrary, exports to CIS countries have enjoyed above-average survival rates.

Significant depreciation of the ruble created an important price advantage for the Russian non-resource exports, which could be fully unlocked by development of innovative products and expansion on the new markets. To gauge Russia's success in development of innovative products and seizing new markets, we need to assess the competitiveness of Russian companies in four innovation archetypes. Industry specific approach provides more insights on the actual innovative performance of certain industries, which could become points of growth.

[1] *R&D intensity is defined as R&D expenses divided by total revenue*
[2] *EU Industrial R&D Investment Scoreboard 2013*
[3] *Russia Economic Report, World Bank Group, April 2016*

Exhibit 27 Assessment of position on the global market

Index: 1=poor, 5 = excellent



Source: authors' estimates based on the McKinsey Global Institute Approach

Industries were plotted on a graph based on innovation archetypes and expert opinions on Russia's position and potential on the global markets. Russia has maintained strength in some industries related to science-based and efficiency based innovation, but lags in engineering-based and consumer-based innovation.

Science-based innovation

Science-based innovation is considered by many to be the highest form of innovation as it not only can lead to high levels of economic development but also can create new industries and may have profound social impact.

The science-based innovation is largely dependent on people, their qualification and availability of human capital. High quality of school and university education allows for availability of necessary skills and qualification of the workforce. Russia historically has an excellent background for the science-based innovation, as the country has been widely accepted as one of the leaders in STEM fields, the educational system is considered to be one of the most advanced. Russian scientists received Nobel Prizes in 2000, 2003 and 2010 most recently, and about one per decade prior to that.

The science-based innovation has been placed near the top of the national agenda, as the country has started recovering its position on the global markets after the economic upturn of the 2000s. Substantial investments have been made in science capabilities. The Russian government has invested in science education to raise the number and quality of scientists and researchers. It has also made efforts to attract Russian and foreign scientists from overseas, increasing connectivity of the country to the global knowledge exchange. This section will provide a detailed review of key indicators related to science-based innovation in Russia, covering the educational system, financing and innovation outputs.

As of 2015 Russia had over 600 state and 480 nongovernmental colleges and universities. According to the QS World University Ratings 2015/2016 there are 21 Russian universities in the list and this number is gradually increasing (18 in the rating for 2013/2014).

Table 11. Russia's Top Five Universities

Name	Ranking by QS World Universities 2015/2016	Research Strengths
Lomonosov Moscow State University, Moscow	108	Mathematics, physics, arts, and humanities
Saint-Petersburg State University	256	Mathematics, physics, arts, and humanities
Novosibirsk State University	317	Mathematics, physics
Bauman Moscow State Technical University	338	Mathematics, physics
Moscow State Institute of International Relations (MGIMO University)	397	Arts, and humanities
Moscow Institute of Physics and Technology State University	431-440	Applied mathematics, physics, electrical engineering, and computer science
Peter the Great Saint-Petersburg Polytechnic University	471-480	Applied mathematics, physics, electrical engineering, and computer science

Source: Federal Statistical Service

The Russian Government has established a goal to have 5 universities in the top 100 by 2020. Among recent efforts addressing this goal has been Russia's participation in the Bologna process. This series of agreements between European countries designed to ensure comparability in standards for courses will give Russian scholars increasing opportunities to study abroad and gain knowledge in biotechnologies and other areas where Russia still lacks competitive advantage.

Every year about 1 million students graduate in Russia, at least 15% of them major in STEM fields of science. Russia demonstrates one of the highest enrollment rate of population in tertiary education among the OECD countries.

Data show that Russia demonstrates relatively high educational attainment.

Table 12. Number of graduates majoring in S&T, manufacturing and construction, per 10 000 population of employed ages 25 – 34 (2011)

Country	Number of graduates
Finland	3053
Rep. of Korea	2421
United Kingdom	2103
Germany	1699
Sweden	1513
Russia	1481
Canada	1313
Japan	1242
USA	1241
Norway	1174
Turkey	770

Source: Indicators of education: 2013, data book. The National Research University Higher School of Economics by the Government of the RF (Table 7.10)

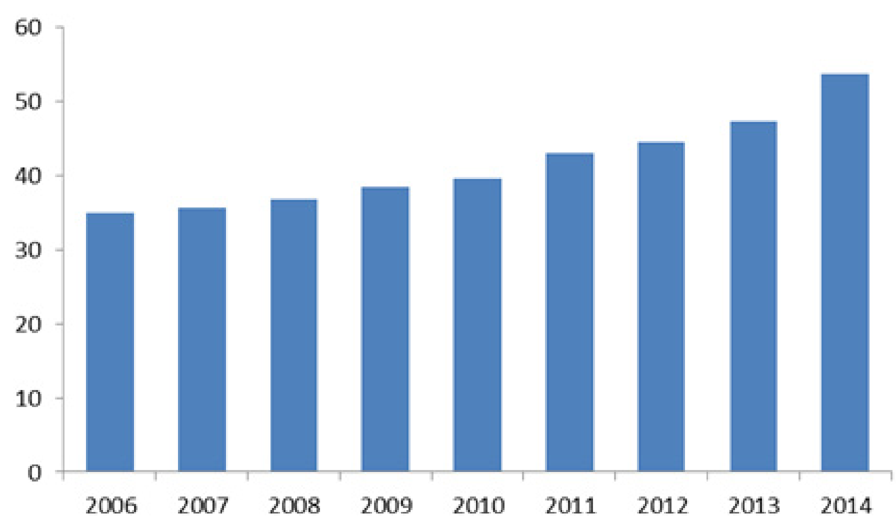
Table 13. Enrollment rate, ISCED (6-8)

Country	Share of population (25-64)
Russia	27.3
Norway	29.8
Israel	34.5
United Kingdom	31.0
Netherlands	31.9
Germany	26.4
Spain	33.6
Canada	28.5
United States	33.5
Finland	29.3
Sweden	28.9
Japan	27.6
Turkey	11.8

Source: Indicators of education: 2016, data book. The National Research University Higher School of Economics by the Government of the RF (Table 7.1)

In terms of innovation outputs Russia's intensive investments in science have led to publication of more scientific papers, and more patent filings, but have not yet fully translated into innovation leadership and commercial successes. A positive trend in publications, indexed in internationally recognized scientific magazines, indicates growing connectivity of Russia's R&D and incorporation of Russian scientists into the global research network. The international connectivity will make it possible to overcome the isolation from the global knowledge exchange which significantly hampers the innovation development.

Exhibit 28 Publications in scientific magazines indexed in Scopus, thousand units



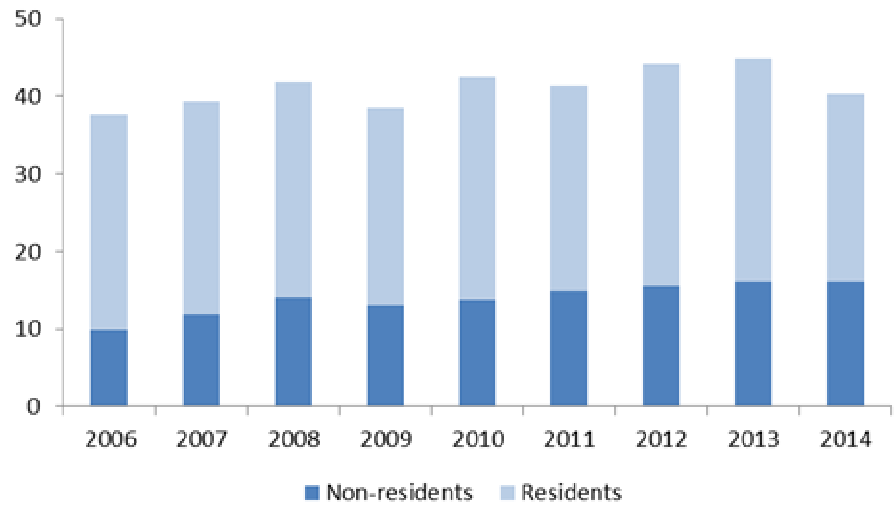
Source: S&T Indicators: 2016, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 6.1)

Thomson Reuters in its report State of Innovations named Russian Academy second to Chinese Academy of Sciences among the most prolific scientific research institutions in semiconductors for the last two years[4].

The number of patent applications and patents granted which are widely accepted indicators of innovation output also demonstrate a steady growth. For the last 15 years, the total number of patent applications and patents granted increased more than 1.5 times. Currently Russia takes the 6th position in the WIPO rank by total number of patent applications among the countries of the world.

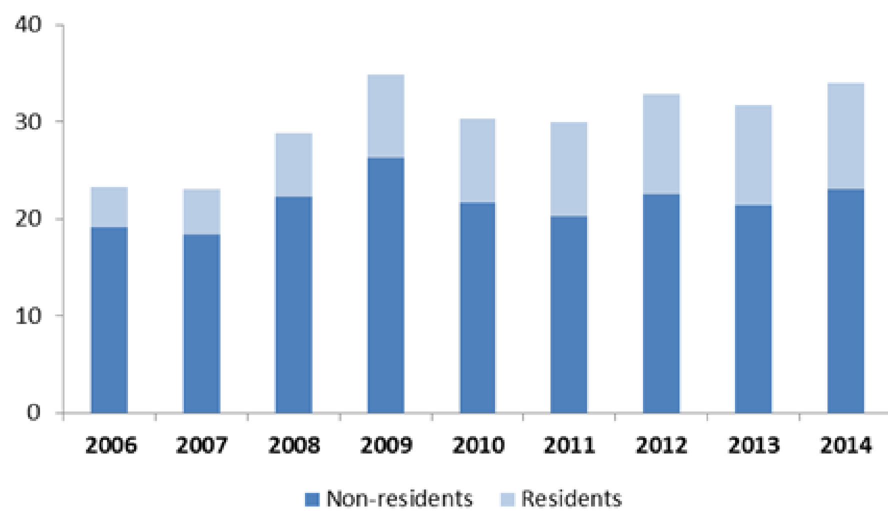
[4] *State of Innovation Report, Thomson Reuters, 2015 and 2016*

Exhibit 29 Number of patent applications, thousand units



Source: S&T Indicators: 2016, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 6.9)

Exhibit 30 Number of patents granted, thousand units

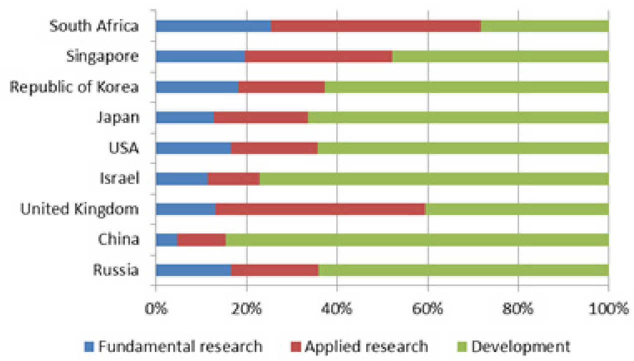


Source: S&T Indicators: 2016, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 6.9)

While substantial progress is being made, the major success can be attributed to the extensive legacy inherited from the Soviet Union. In other science-based industries Russia's position is still rather limited. There are a number of reasons for the limited results from Russia's recent push into science based innovation, including still insufficient financing of research activities and lack of effective incentives for private-sector R&D. There is also a matter of time which should be taken into consideration. It is relatively easy to give up positions on the frontier, but it is very difficult to regain them. Development process for new drugs or materials may take as long as 10 – 15 years in some areas. Therefore results of proactive S&T policies and innovation support will only be evident in some years' time.

The success in science-based innovations is greatly dependent on amount of financing. In recent years Russia has faced significant increase in the level of gross domestic expenditure on R&D (GERD). Financial resources have been channeled to support the research sector and revitalize the research infrastructure, attract talents and regain leadership. Significant portion of GERD is allocated to support the fundamental research, which builds the basis for science-based innovation.

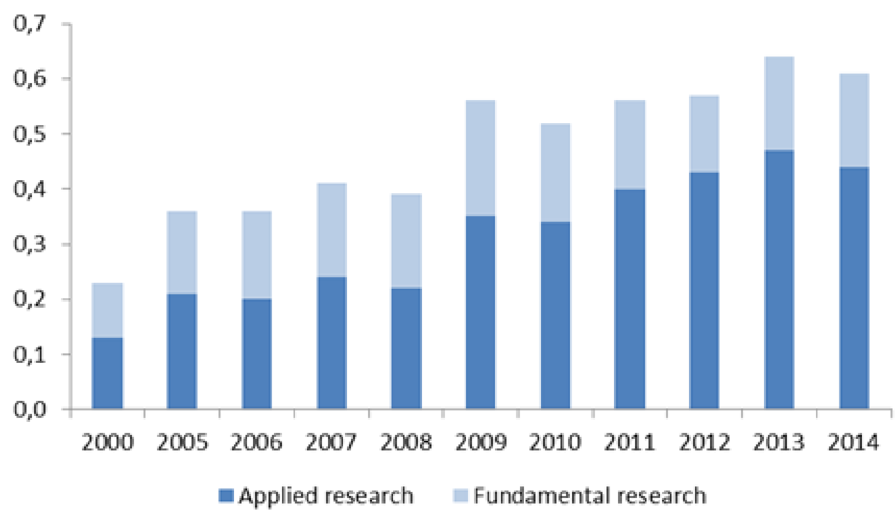
Exhibit 31 GERD by types of research, % in 2014



Source: S&T Indicators: 2015, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 8.6)

The Russian government pursues an ambitious goal of revitalizing the R&D sector and developing the capabilities of the science. It continues to be the largest funder of the civil S&T. The level of federal budget appropriations on civil S&T has grown nearly twofold for the recent years.

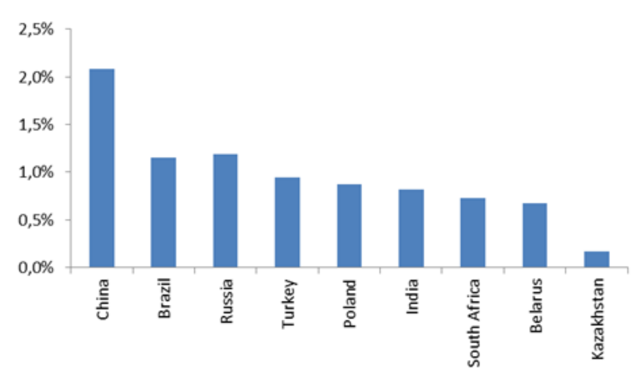
Exhibit 32 Federal budget appropriations on civil S&T, % of GDP



Source: S&T Indicators: 2016, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 3.5)

Despite spending approximately $40 billion per year on research, Russia's GERD level still stands at 1.1% level, which is below the average for the leading developed countries, however higher than that of India's and South Africa's. Ranked by percentage of GERD to GDP Russia is third to China and Brazil among the BRIC countries and unconditional leader among CIS economies and majority of countries of the Eastern Europe (see the table below)

Exhibit 33 GERD, % of GDP (2014)



Source: S&T Indicators: 2016, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 8.2), WDI S&T Indicators 2015

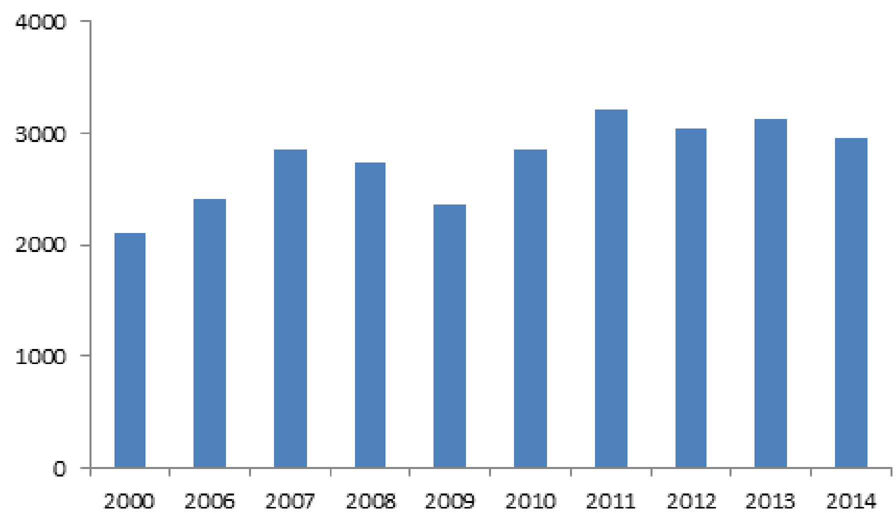
The limited amount of GERD can be partially explained by the industry structure of the economy, but the key reason is low level of involvement of a corporate sector. Russian government is a key funder of R&D expenses.

Business enterprises, including state controlled enterprises, account for approximately one-third of GERD. Russia is second only to the United States in terms of absolute amount of government financed commercial innovation (BERD) accounting for $14.9 billion (USA – over $35 billion) and the world leader in relative terms (0.4% compared to less than 0.25% for the USA and Republic of Korea and less than 0.1% for China).

The business sector in general and state controlled enterprises in particular still demonstrates relatively low involvement of financing of research activities. Another important obstacle is disconnectivity between research and commercialization of innovation. To get the market share research should be converted a ready for use product or technology. Innovation system should allow smooth transfer of knowledge from research to commercialization, but here Russia faces a gap.

To gauge the knowledge transfer we use the number of licensing agreements, as the results of R&D activities need to be transferred to the producer of a final good or services. Russia's strategic document on innovations (Strategy 2020) even provides a KPI on number of licensing agreements; though the most important parameter – monetary volume is not monitored. Increase in patenting activities is followed by the growth in commercialization, including various types of licensing agreements, but the number of agreements is still very low.

Exhibit 34 Number of licensing agreements, units

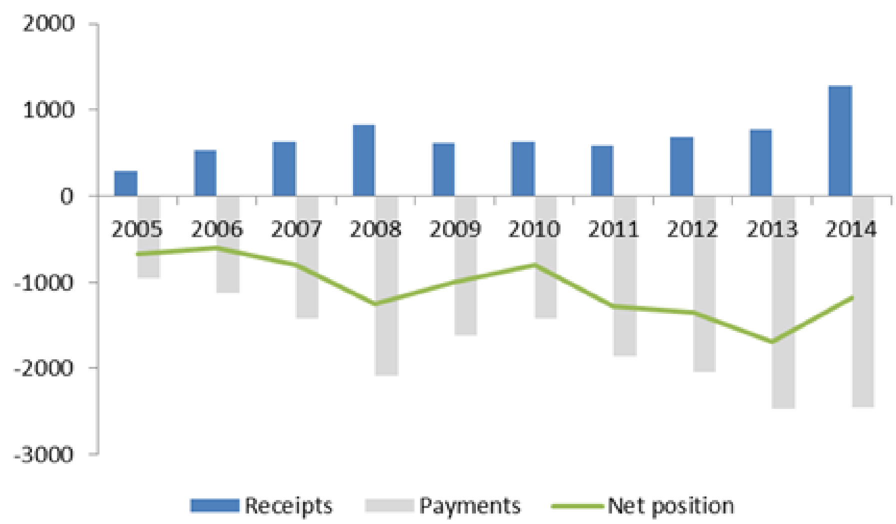


Source: S&T Indicators: 2016, Data Book. National Research University Higher School of Economics by the Government of the RF (Table 6.15)

Another metric to measure commercialization is the technology balance of payments (TBP) data, which register the international flow of industrial property and know-how (e.g. through patent purchases and licensing, trademarks, technical services, etc.) This shows a rapid increase in payments and receipts in recent years. The growing TBP reflects the growing internationalization of Russian industry.

Russia is a net importer and demonstrates a deficit in terms of TBP with the rest of the world; payments were approximately 3.0 times receipts for the recent years. Key sources of receipts are engineering services (slightly over 50%) and R&D activities, while major sources of payments relate to engineering services and trademarks.

Exhibit 35 Balance of payments on technology transfer, USD mn



Source: S&T Indicators: 2016, Data Book. The National Research University Higher School of Economics by the Government of the RF (Table 6.19)

Success stories of industries and future growth points

As it has been previously mentioned, Russia benefits from the science background developed in Soviet Union, the most successful industries are space and nuclear technologies to name a few. Space technologies is one of the most developed domains of high-tech where Russia still maintains leading positions on the global markets. According to the Thomson Reuters report on Innovations[5], five out of top-10 space technology innovators in Europe for 2011 - 2015 are from Russia.

Table 14. Top 10 Space Technology Innovators

Company	Country	Number of inventions	Share to 2014
Airbus	France	225	62%
Energiya Rocket	Russia	113	58%
Information Satellite Systems Reshetnev	Russia	80	76%
Thales	France	73	82%
Center Nat Etud Spatiales	France	42	96%
Mechanical Engineering Research Institute	Russia	61	87%
Cosmic Scientific Production Centre	Russia	41	85%
Deut Zent Luft & Raumfahrt	Germany	32	84%
Snecma	France	24	-
Moscow Mars Experimental Construction Bureau	Russia	19	

Source: 2016 State of Innovation Report, Thomson Reuters

This highly centralized and state dominant system allows for breakthrough in innovative areas but lacks commercialization approach, which is currently becoming more and more critical. However this system is changing and a number of private companies has already emerged and ventured to pursue for innovations in the areas where the government dominance has been previously beyond question. As time passes they may become national champions and enter the global markets. Space technologies and infrastructure is usually associated with launch vehicles, satellite opera-

[5] *2016 State of Innovation Report, Thomson Reuters*

tions and services, human spaceflight, and other critical functions. This traditional landscape is quickly transforming. After years of steady and respectable growth the space industry appears to be on the cusp of a new era of rapid expansion in both capabilities and customers. Startup companies which have never operated in the industry before nowadays are experimenting with novel approaches for building and deploying constellations of spacecraft and delivering services to their customers in new ways. The nature and size of rocket payloads, the satellites, are changing. Last year slightly less than half of the nearly 300 satellites launched weighed 10 kilograms or less. In 2014, a single Russian space launch vehicle launched and deployed a combination of 33 small satellites and cubesats into low Earth orbit. We are proud to say that Russian companies, such as Dauria Aerospace and Sputniks also took part in this space competition.

Dauria Aerospace is a Russian private company which has been specializing on development of small satellites since 2012. Currently it is one of the fastest growing private space companies. By now Dauria developed four satellite platforms ranging from 10 kilogram to 1 ton and has already performed flight tests of two of them. In 2015 the company achieved commercial success by selling two Perseus-M satellites. The technology makes it possible to build a satellite constellation with capabilities of global coverage of the Earth's surface. The remote sensing results can be used for climate control and human activities studies, agriculture and forestry, meteorology, provide relevant data for traffic control and emergency services. Dauria is currently developing a new promising platform for satellite Earth observation in high resolution and a few instruments for Russian astrophysical research in space. The company's plans are to build a full-scale constellation to provide services for the remote sensing of the Earth.

Biotechnologies and more specifically branded pharmaceuticals like space technologies is a highly concentrated industry. Currently it is heavily dominated by a few international companies, such as Pfizer, Glaxo Smith Kline, Abbott Laboratories, and Eli Lilly. It is worth mentioning that the competitive landscape in biotechnologies is also changing. More money is being funneled into biotech startups. Based on a report in The New York Times by Hiroko Tabuchi, the global investments in biotechnology start-ups rose 26 percent in the first half of 2014 to approximately $3 billion, and are on track to exceed the 2008 peak of $5 billion. New areas are emerging, such as personal genomics and gene-editing. More and more attention is being paid to the agriculture. The First Oncology Research and Advisory Center (FORAC) is conducting research in the field of bioinformatics in order to develop a personalized cancer therapy platform. The personal approach towards cancer therapy is very important, as every year more than 14 million new cases of cancer are discovered all over the world. Today 1 out of 7 deaths worldwide occur due to cancer, more than from HIV / AIDS, tuberculosis and malaria combined. The FORAC's platform has already been implemented by doctors to prolong productive life for patients with cancer and other age-related diseases. FORAC is actively cooperating with the international partners, such as Insilico Medicine (USA) and Pathway Pharmaceuticals (Hong Kong). In June 2015 FORAC, IBM and Skolkovo Foundation have signed an agreement, which provides for development and implementation of a personalized medicine platform in Russia.

What's next?

Russia is actively investing in science-based innovation and still competitive in leading areas, however the country must make a significant breakthrough to enlarge its areas of leadership in order to maintain the current position.

Attainment of talents and increasing connectivity to the global cooperation are the key factors which will lead to success in this field. Russia has sourced many talented scientists and researchers to the global research market and it is high time to get use of their experience. China can provide a good example of successfully implemented state program on talents repatriation. From its inception in 2009 to May 2014, the Chinese Thousand Talents program attracted more than 4,000 returnees, more scientists than had come back to China in the preceding 30 years.

Development of universities and implementation of new university-based research model, deepening of cooperation between business and academia, creation of global innovation centers connecting Russia to the global innovation network are also important steps in order to maintain global leadership in science-based innovation.

Engineering-based innovation

Engineering-based innovation greatly depends on knowledge and experience accumulated in the national economy. In industries such as autos, communication equipment, and high-speed trains, innovations are part science and part problem solving, based on know-how that can take years of learning by doing and experimentation.

Engineering-based innovation also involves project management experience of integration technologies from multiple sources to form a single product. For example, developing and assembling a new airplane requires collaborating with hundreds of suppliers and integrating more than 1,800 different components to produce a coherent design. Building the capacity to conduct engineering-based innovation involves several stages, the first stage assumes learning core capabilities, then building skills in incremental innovation, and finally operating at the innovation frontier.

In Russia, engineering-based industries are progressing at different rates along this roadmap. The speed is determined by opportunities to gain knowledge and capabilities of companies to absorb them. Yet again the quality and availability of human capital is a crucial factor for engineering-based innovation to succeed.

Availability of highly qualified R&D personnel is a distinguishing feature of the Russian economy. Russia demonstrates a high number of R&D personnel both in relative terms (per ten thousand employed) and in absolute number.

Table 15. Total R&D personnel, 2014

Country	FTE per 10 thousand employed	Thousand FTE
Russia	122	829.2
China	46	3532.8
Brazil	28	266.7
United Kingdom	121	362.0
Germany	143	603.9
India	10	441.1
Italy	104	252.6
Canada	125	223.9
Rep. of Korea	160	401.0
France	156	420.6
Japan	133	865.5

Source: S&T Indicators: 2015, Data Book. The National Research University Higher School of Economics by the Government of the RF (Tables 8.8 and 8.9)

Availability of industrial clusters with concentration of R&D centers and production facilities is an important factor for engineering-based innovation. Mature industrial ecosystems in such clusters allow minimizing the time-to-market which is critical for engineering-based innovation. The Russian government has been pursuing an initiative to launch special economic zones aimed at technology implementation as well as industrial clusters with industry focus.

International cooperation is an important factor, as an engineering-based innovation is based on knowledge exchange and accumulation of experience. Nowadays development of every complex engineering product is a project which is not limited by boundaries of a single country. A car, a high-speed train, a plane or helicopter is developed by a large team of engineers from several countries, and is compiled of parts produced in a number of countries. And what is more important every truly competitive project requires a global market due to significant initial investments. Small-scale production requires high costs which move the product out of the competition.

Unfortunately, currently limitations on technology transfer and investment attraction imposed by the Western countries hamper engineering-based innovation. Nowadays it is harder to enter and operate Western markets, growth based on acquiring knowledge from the international partners will be slowed down. Russia's turn to Asia is an important step to open new markets and establish new connections vital for economic development.

The government can play a prominent role in fostering engineering-based innovation through policies that encourage technology transfer and global cooperation, as well as government purchasing activities. At the same time excessive regulation can hamper growth as it protects inefficient and inflexible players.

In Russia, government has been a successful catalyst of learning for a few engineering-based industries. In others, the record is mixed. The most of best performing companies have benefited from government purchasing policies and government facilitation of partnerships with leading international companies that have resulted in knowledge transfer. These companies have managed to go through a cycle of acquisition, assimilation, and improvement of foreign technology. The growth formula included the following components: know-how and experience (for some industries knowledge capital may include experience gathered not only by civil but also by defense industries), international partners willing to enter the market and share technologies, qualified engineering staff to absorb and develop technologies and to cap it all the government eager to foster industrial growth in some industrial cluster.

Success stories of industries and future growth points

Knowledge and technology transfer process may take significant time depending on the gap with the industry leaders. By now, Russia had relatively limited time to catch up and move along the knowledge curve. In order to recognize industries which are mature enough to compete on the international markets we looked at the product structure of Russia's machinery export which is usually associated with engineering-based innovation. In general, the share of high-tech industries is rather limited, for example, telecommunications and electronics account for less than 10 percent. However there are two industries where the innovation roadmap was more or less successfully implemented leading to a significant change in the competitive position on the international markets. These are auto manufacturing and commercial aviation.

The history of innovation in the Russian auto manufacturing illustrates some of the ways Russian companies and government used to acquire the knowledge and technologies needed for development. More specifically, it is the government policy that had key impact on the revival of the Russian auto manufacturing, where technology transfer, local-content regulations, and investments in domestic capacity deepened Russian engineering capabilities.

In the 1990s, Russian auto manufacturing faced a deep crisis. The national producers fell behind the modern technologies and did not pay attention to the quality control. As a result, they faced sharp decline in all segments from cars to heavy trucks, significant portion of the market was occupied by the second-hand cars imported from abroad. Russia's auto industry was on a brink of collapse. However the government made a set of efforts trying to build a set of industrial clusters focused on the automotive industry and supplies. To revitalize the automotive industry, the government widely attracted foreign companies to launch new capacities, but when the key players entered the market it imposed localization rules requiring gradual increase of the local content. As a result of localization efforts, several industrial clusters emerged where key international suppliers of components launched production. These are major industrial clusters at Togliatti (AutoVaz – Nissan), Kaliningrad (Avtotor – BMW, Chery Automobile, GM, Kia Motors, NAC), Yelabuga (Ford), Saint-Petersburg (Ford, Toyota, Nissan), Kaluga (VW, Volvo).

In all cases the critical success factor was support by the state and regional authorities which provided tax and regulatory benefits, as well as provided the necessary infrastructure. Later on, as the market became more and more mature the manufacturing turned to be more and more localized. It took approximately 10-15 years to completely reboot the market.

Commercial aviation is another example. Russia has inherited a set of aircrafts constructed in the Soviet Union, most of which traced history of its first flights to 1960s – 1970s. Russia's government has made several attempts to support the commercial aircrafts, but project Sukhoi Superjet-100 (SSJ-100) became the most successful in terms of production and coverage of markets. SSJ-100 was the first aircraft ever designed in close cooperation with international companies and with due consideration of requirements and demands of potential worldwide operators. Development of SSJ-100 was led by Sukhoi Aircraft Company, which was famous for its defense planes (e.g. Su-27), but had no previous experience in commercial aircraft development. In order to achieve success, Sukhoi Civil Aircraft Company attracted Boeing, one of the world's leaders in commercial aircraft, to provide consulting services in the field of marketing, design, manufacturing, certification and quality system, supplier management, and after-sales support. The jet has received a completely new engine, SaM146, which was developed by PowerJet, a joint venture of Snecma, a globally recognized engine manufacturer, and NPO Saturn, a Russian aircraft engine producer. The SSJ-100 is a project of international cooperation, the share of imported parts is approximately 50%. The key suppliers are Thales (avionics), PowerJet (SaM146), B/E Aerospace (oxygen system, interior). Currently over 90 planes have been built, they flight in 6 countries (Russia, Mexico, Laos, Indonesia, Switzerland, Ireland).

However the future of auto manufacturing and commercial aircraft is not as cloudless as it may seem. The current economic turmoil which created opportunities, at the same time, has imposed threats on their development. Russian car market has been experiencing decline for two consecutive years, as sales have plummeted more than 50% in comparison with the pre-crisis 2013. A number of companies either limited their presence or even halted operation on the market. However other producers are going to continue production but focus more on export operations, as now Russian-assembled cars look less expensive than the ones produced in Europe.

Russia's efforts to catch up with competitors in commercial aviation have been severely hampered by lack of initial project management experience and limited access to global learning networks. With millions of parts from hundreds of suppliers, aircraft are among the most complex products to design and build. Even the most experienced global companies have trouble managing the aircraft system integration to mention multibillion-dollar delays while developing Boeing-787 or Airbus-380. Russia's competitors – Mitsubishi Regional Jet and ARJ21 have also faced delays and deviations from initial project plans and specifications.

Russia's companies have no shortcut for acquiring the end-to-end knowledge of aircraft production. Through all the troubles and delays the SSJ-100 will gradually develop. Moreover, Irkut Corporation is steadily developing another aircraft MC-21, its first flight is scheduled on 2016. Ilyshin Aircraft Company is considering restarting of production of the long-range airplane Il-96, the first wide-bodied long-range aircraft developed in the last years of the Soviet Union and produced by a very limited edition.

One of the key problems of Russian aircraft producers is the limited demand which does not allow them gaining benefits from economy of scale. For example, number of Embraer E-Jet planes which made its first flight in February 2002 exceeded 1100 planes. The possible way of breaking through the "low demand" trap is cooperation with Asian companies in order to combine and get synergy from the portfolio of know-how.

There are number of industries where engineering-based innovation is gradually gaining pace, among them are the medical devices and equipment, telecommunication equipment, oil and gas engineering and equipment manufacturing, modelling and engineering software to name a few. For example, according to the Thomson Reuters report on Innovations[6], Russian company Tatneft is in the top-10 global innovators in the oil and gas industry.

Datadvance is an innovation company which has developed an advanced software tool for modelling, intellectual data analysis and optimization which helps industrial companies decrease product design time, optimize costs and enhance product performance. The company originates from the Russian Institute of Information Transmission Problem (IITP RAS) and Airbus Group (former EADS). The company's development team is based in Moscow with offices located in Toulouse, France and Munich, Germany. The tools have already been implemented by both the leading Russian (KAMAZ, AutoVAZ, Ural Turbine Plat, SPC Sapsan) and the international companies – Airbus, Micheline, Mitsubishi. For example, Airbus has used DATADVANCE software to develop its modern Airbus A350 XWB, just as a result of this technology the lead time and costs in several areas of the aircraft design process were reduced by approximately 10%. Potential use cases may include such industries as aerospace, automotive, electronics and electrical appliances, turbomachinery, biotech and pharma.

Rock Flow is a Russian startup company, participating in the Skolkovo project. It has developed an innovative software to simulate the development of oil and gas fields. The technology allows creating interactive 3D-models for the oil and gas deposits and provides tools to work out scenarios for further development for example define methods of drilling and well placement. Now it takes only a few minutes to prepare data for the analysis. Major Russia's oil and gas companies including Gazprom, Rosneft, Lukoil, Novatek, Bashneft are using the software by Rock Flow Dynamics. The company is also actively working in international markets, attracting clients from all over the world. The clients list of international companies includes JogMec (Japan), KNOC (South Korea), Halliburton, Repson, Murphy Oil (USA), Petrochina, CNPC, Zhen Hua Oil (China), Kuwait Oil Company (Kuwait), BG Group, Apache Corp, EnQuest, Tullow Oil, E-On (UK), Petrovietnam, Hoang Long (Vietnam), Ara Petroleum, Petroleum Development (Oman), Tatweer Petroleum (Bahrain), KazMunaiGaz (Kazakhstan), Amni International (Nigeria) and many others. The company's software is currently used to build models of fields in virtually all parts of the worlds except for Antarctic Continent.

[6] *2016 State of Innovation Report, Thomson Reuters*

What's next or new trends of industrial development: Industry 4.0

The forthcoming shift to an all-digital global manufacturing industry policy brings new threats and opportunities. Around the world, manufacturing leaders and governments have recognized the profound challenge the new industrial revolution presents. Industrial groups such as the Industrial Internet Consortium have been established to help advance the technologies needed, and governments have created long-range initiatives to support their manufacturing sectors in the transition to Industry 4.0.

Russia has also joined the Industry 4.0 transition. In August 2015 during the MAKS 2015 airshow Russian Space Systems and Rostelecom (Russian national telecom operator) signed an agreement on creation of the Association on Industrial Internet development.

What should be done to facilitate engineering-based innovaiton? Stimulus for international cooperation and knowledge transfer complemented by targeted support measures of local producers are primary instruments. This type of innovation will drive Russia across of economic development scale, but it requires both measures of economic development and knowledge transfer. Joint project with Asian countries, primarily China, could benefit both parties as they may combine benefits – Russia's talent and capabilities with Chinese market and production infrastructure.

Efficiency-driven innovation

Efficiency driven innovation involves new ideas that save time and cost in the development, production, and delivery of goods and services.

Despite significant improvement, Russia has immense yet still unlocked potential of increasing labor and capital productivity. For example, according to the McKinsey Global Institute, in 2012 the Russia's GDP produced per hour of work was 39 percent of the US figure. Though the overall level has increased from 29 percent in the mid-2000s, it is still lower than in the Eastern European countries and accounts for only 45 percent of the EU level.

Low productivity level was partially offset by growth of working hours. Russia is one of the world leaders in terms of working hours per capita (985 hours per year); it is second to the Republic of Korea only and outpaces other countries of OECD. The future intensification of working hours is problematic as unemployment is relatively low and the workforce has already passed its peak. Thus attention should be paid on improvement of facilities and optimization of business processes.

Unfavorable economic conditions make the things harder. Limited access to financing and economic instability has led to decrease of investment. In 2013 investments accounted for 23 percent of GDP, in the recent years the level of investment faced further downfall to 21%. Deficit of investments leads to ageing of production facilities. Based on the experts estimates (Alfa Bank, economic report, 1H2015) the average life of fixed assets in Russia has increased in almost all the key manufacturing sectors. In metallurgy it has grown from 17 to 20 years, in production of machinery and equipment it increased from 15 to 17 years, in oil refinery it is going to hit 22 years starting from 18 years for the period from 2011 to 2013.

At the same time current economic turmoil has pushed the salaries and prices for resources back to a competitive field. Another way of pursuing efficiency-driven innovation is organizational improvements which include business process optimization, lean production and other forms of process optimization. In general the level of involvement is rather limited; however it is gradually increasing as industry leaders disseminate the best practices.

Success stories of industries and future growth points

Steel-making is an example of successful implementation of efficiency-driven innovation. The success was possible due to combination of high demand on global markets, low prices for resources and involvement of large business under the government support. It is worth mentioning that approximately 40% of production volumes are exported.

In the early 90s, production volumes of steel dropped almost twofold, a sharp decline was followed by a long period of stagnation. The industry revival started since late 90s due to growth of global demand for steel and lasted for approximately a decade. The production volumes increased 5 percent annually and what is more important the industry faced unprecedented productivity growth. For example in 1999, the overall productivity in steel industry accounted for only 33 percent of the US level, by 2007 the overall productivity achieved 54 percent of the US level with the industry leaders taking 77 percent[7]. For the short period of 2006 – 2011 two modern plate mills 5000 were put into operation (Magnitogorsk, MMK and Vyksa, OMK) in addition to the only plate mill inherited from the Soviet Union. Russia

[7] *McKinsey Global Institute, Lean Russia: sustaining economic growth through improved productivity*

joined the limited group of country having such complex facilities, currently less than fifteen such mills are in operation around the world.

The prerequisite for efficiency-driven innovation is the development of mature manufacturing ecosystem. The richer and more competitive is the ecosystem of suppliers and producers the more adaptive capacity and drive for innovation it has. In order to gain momentum production ecosystem should reach some critical size and sophistication. Concentration of skills and facilities allows decreasing time to develop a prototype by two or three-fold, and decrease costs respectively. Targeted government policy is also an absolute prerequisite for success in efficiency-driven innovation. Russia's innovation imperative is in many aspects related to the efficiency-driven innovation. Obstacles of ageing workforce and excessive resource-intensiveness which hamper economic growth could be removed only through efficiency-driven innovation.

Russia is actively implementing cluster-based approach developing industry focused clusters. A number of clusters has emerged recently, for example Saint-Petersburg (auto manufacturing), Kaluga (auto manufacturing and pharma), Zelenograd (microelectronics). The state and local authorities have played a critical role in pursuing cluster-based approach, providing administrative, regulative and financial support (for more details see next chapter).

Russian industry champions are gradually implementing a range of innovations to improve efficiency and accelerate speed of product development. Russia has been out of this trend for a long time, but now automation and process improvement is becoming more and more popular. Banking and automotive industries that were previously considered performance laggards, currently implement cutting-edge technologies and best-practices. For example, Sberbank is a champion in implementing of lean-production and new IT technologies, including voice and face recognition.

Customer-focused innovation

In general Russia is considered a resource-based economy, but approximately half of the Russia's GDP is comprised of consumer-based industries, including finance, services, education. With population of over 140 million, Russia even after the recent economic downturn is one of the largest markets in Europe and still takes a prominent position on the global consumer markets. The adjustment of the economy has translated into reduced household purchasing power and weakened consumer demand. At the same time currency devaluation created competitive advantages for national providers as many imported goods turned out to be more expensive. The large consumer market could provide innovators a huge supply of needs to satisfy and earn profits.

Table 16. Population and GDP per capita, 2014

	Total population, mn. People	GDP per capita, th. USD*
Russia	143.8	23.3
Kazakhstan	17.3	23.1
Brazil	206.1	15.1
China	1 364.3	12.6
India	1 295.3	5.4
South Africa	54.0	12.4
France	66.2	37.2
Germany	80.9	43.4
Italy	61.3	33.1

Source: World Development Indicators
**GDP per capita, PPP (constant 2011 international $)*

In general the consumer-based innovation is pursued by SMEs, which are fast and flexible enough to read and satisfy consumer needs. For example, in Asian countries, and China is not an exception, the customer-focused innovators turned out to be the core of the country's innovation system. The first wave of the Asian customer-focused innovators was manufacturers of goods and appliances and other household goods, which were capable of producing "good-enough" but very cheap products. However in Russia the first customer-focused companies got involved in importing and trading but not in production.

To realize the full potential for customer-based innovation, Russia will need to support and facilitate the emergence of innovative entrepreneurs and SME sector. Unfortunately, the current level of entrepreneurial activities and involvement of SMEs is significantly lower than that of peer BRICs companies. Only 10% of SMEs are involved in innovative activities. As Russia's consuming class has grown and reached by various estimates from 10 to 28 million people (7 to 16 percent)[8], Russian companies are trying to get the market share and develop products and services to serve those needs.

Russia's private entrepreneurs and SME sector is steadily growing in numbers, the total number of private entrepreneurs exceeded 2.5 million; the total number of small and micro enterprises is roughly 2.4 million units. The growth rate and impact could be higher if entrepreneurship were more popular among the population of Russia. The Global Entrepreneurship Monitor's survey indicates that only 4.7% of Russia's working age adults are early-stage entrepreneurs. Unpopularity of entrepreneurship in Russia can be partially explained by the negative perception of entrepreneurial opportunities of those not currently in business. Only 18% of non-entrepreneurs consider the external conditions favorable for starting up a business; for entrepreneurs, the figure is more than double. Fear of failure prevents 42% of non- entrepreneurs from starting up. The average early-stage entrepreneur is male, aged 25 - 34, with secondary and post-secondary education.

Customer-focused innovation in Russia is hampered by relatively weak development of SMEs and entrepreneurs focused on development and production of innovation goods and services. The innovation activity of Russia's companies is still low in comparison to the BRICs peers. SMEs prefer more traditional industries, such as trade, construction and services.

Table 17. Innovation activity of business enterprises, including SME, % of involvement (2014)

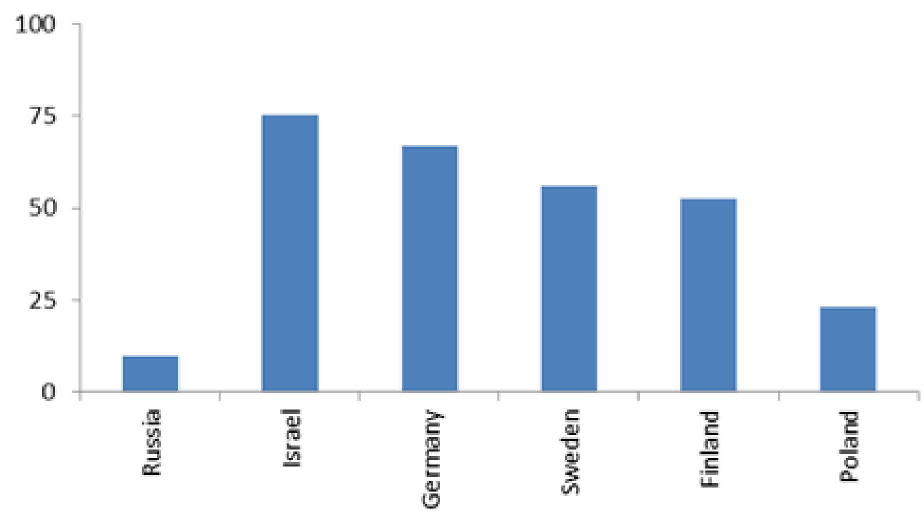
Total	9.9
less than 50 FTEs	3.0
50-99	6.6
100-199	10.5

Source: Indicators of innovation in the Russian Federation, 2016. The National Research University Higher School of Economics by the Government of the RF (Table 2.4)

Entrepreneurship continues to play a small role in the Russian innovation economy, not only in comparison with other BRICS (Brazil, Russia, India, China, and South Africa) countries but also in comparison with countries of Eastern Europe.

[8] *Center of social policy of RAS, Center for Strategic Research*

Exhibit 36 Innovation activity of enterprises, %



Source: Indicators of innovation in the Russian Federation, 2015. The National Research University Higher School of Economics by the Government of the RF (Table 8.1)

Success stories of industries and future growth points

Russia's IT sector is a leader in terms of customer-based innovation. It comprises such industries as social networks, e-commerce, advertising and access to banking and financial services. Easy access to consumers, low level of entry barriers and high availability of talents provides for high rate of success stories at the country and partially on the global level. Nginx is a Russian web-server that currently takes the third position in the world by popularity. Social network Vkontakte (Vk.ru) is focused on the customer base of the Russian speaking segment of the Internet and keeps the strong competitive position there. Acronis is a world famous leader in terms of HDD management, data back-up and related services. Kaspersky Lab is one of the leading anti-virus software. The government has made significant steps in order to improve framework conditions for business and foster the customer-based innovation. Russia has made tremendous progress in the Doing Business rating, however it stands in the very beginning of this path. Growth points are related to implementation of engineering-based developments into production. IT is a leader, as it is most marketable, widely recognized and supported by skills and financing. However the future of technological entrepreneurship is linked to turning highly skilled engineers and young scientists into entrepreneurs, ready to launch a startup and commercialize their inventions. The government development institutions which organize programs on popularization and develop regional entrepreneurial societies play important part in that.

What's next: Cambrian explosion or the Great Dying of startups?

For the last few years, the popularity of tech startups has been growing. More and more teams are entering the market. Research conducted by the Skolkovo Foundation was named the Cambrian explosion[9], after the huge breakthrough in terms of number and variability of startups in Russia. But the recent economic conditions put the growth into challenge, lack of financial resources, economic uncertainty, and decline in private consumption – all these factors may turn the Cambrian explosion into the Great Dying. We believe that the current turmoil makes the startup ecosystem more mature. Crisis creates new opportunities; Asian markets can be one of such breakthrough opportunities.

[9] *The Cambrian explosion, Skolkovo Foundation, June 2015*

RUSSIA'S POLICY TOWARDS INNOVATION DEVELOPMENT

Overview and key documents

The government policies play a crucial role in the development of the national innovation system, they define its capabilities, create strong points and try to mitigate risks. The foundations of Russian innovation policy were launched in the mid-1990s. At that time, the interest in innovation arose from a concern to protect and restructure scientific activities under crisis conditions. It took about a decade for the concept of a national innovation system to develop and gain wide recognition.

In 2002 a presidential decree approved *The Principal directions of the Russian Federation policy in the sphere of development of innovation system for the period up to 2010*. For the first time the need for transition to innovation-led economic development was emphasized at the state level. This high-level strategic document was the first to define the Russia's objectives of S&T policy from an innovation system perspective.

The Strategy of Development of Science and Innovation in the Russian Federation for the Period up to 2015 was approved in 2006 by the Interdepartmental Commission for Science and Innovation Policy, chaired by the Minister of Education and Science. Its main stated objective was "the formation of a balanced effective R&D innovation system, providing the technological modernization of the economy and enhancing its competitiveness through advanced technologies and the transformation of scientific potential in one of the major resources for sustainable economic growth". The first important step in the implementation of this new strategy was the *Integrated Program of Scientific and Technological Development and Engineering Modernization* of the RF economy until 2015, elaborated in 2007 by the Ministry of Education and Science in 2007.

The Concept of Long-term Socio-economic Development of the Russian Federation for the Period up to 2020, was adopted in November 2008. It is a founding document which defines the strategy of Russia's economic, including the goals, trends and key targets of the national innovation system development. The Section 6 of the document ("Development of national innovation system and technology") defines how the creation and dissemination of innovations in all sectors of the economy should contribute to the achievement of development goals.

The recent state policy on innovation development is based on *The Strategy on Innovation Development of the Russian Federation up to 2020 and further perspective (Innovative Strategy 2020*). This document was created in order to translate the concept of long-term socio-economic development into a more fully articulated innovation strategy, with clear objectives, priorities and instruments of state support.

The Innovative Strategy 2020 is currently a founding document on the Russia's innovative development. It has prepared background for development of more detailed documents and road-maps which will be described at a greater depth later. The document was developed just after the economic turmoil of 2008 – 2009 which highlighted the necessity to further transform the economy and decrease the dependence on export of resources (oil and gas, metals, etc.). The state has responded to the threats and risks of resource export depended model of growth by launching a long term programs of economic development. Innovation has become a watchword at the highest level, with the creation, in 2009, of a Presidential Commission of Modernization and Technological Development and also, a year later, the rise in importance of the Commission of High Technology and Innovation. Resources have been further concentrated on strategic research centers or centers of excellence.

The Innovative Strategy 2020 sets out the objectives of coordinated reforms and measures on a broad front, grouped under a number of key headings that are generally consistent with those of the OECD Innovation Strategy: innovative people, innovative firms, innovative government, an effective science system, and supportive infrastructures, participation in global innovation networks, innovative regions and territories.

The Innovative Strategy 2020 is a core document reflecting state goals, objectives and indicators in the field of innovative development. The new policy targeted many of the missing components in Russia's National Innovation System by setting goals for R&D, education, financing, and operational responsibility. Among some of Strategy 2020's broad mandates are: (1) incentives to students studying engineering and applied sciences; (2) stronger integration of international cooperation on innovation; (3) improvement of the education system, including entrepreneurship and technology management; and (4) the development of Technology Platforms, aimed at bringing together stakeholders in the most promising technological areas in order to bridge the gap between science and industry.

The strategy outlines the following key goals and objectives:

- Development of talent pool in science, education, technologies and innovations;
- Raising the innovative attractiveness of business and speeding up the emergence of new innovative companies;
- Implementation of state-of-the-art innovative technologies in the activity of public administration authorities at the widest possible scale;
- Shaping a balanced and sustainable sector of research and development;
- Ensuring the openness of the national innovative system and economy, as well as the integration of Russia in the global processes of innovations' creation and use;
- Intensification of the innovation policy implementation activity performed by the government authorities of the constituent entities of the Russian Federation and municipalities.

It envisions two phases: unleashing the innovation potential of the business sector and phasing out government support.

- The primary objective of phase one of the Strategy for Innovative Development of the Russian Federation for the period until the year 2020, covering the period of 2011–2013, is to increase the sensitivity of business and economy to innovations by means of the following activities:
- Ensuring greater attractiveness of promising high-tech sectors of the economy to investors (their development priorities were established by the President of Russia);
- Contributing to capital flow and attracting the most qualified personnel to the key sectors through the implementation of a set of fiscal, tariff and other types of government regulatory measures, as well as various types of financial support;
- Modernization of the economic sectors in which Russia does not have any short-term prospects for achieving global leadership, specifically through the tax incentives encouraging re-equipment, favorable customs regulations for equipment import and the tightening up of technical regulation requirements;
- Developing competition in economic sectors, encouraging innovative behavior of the companies, co-owned by the government and natural monopolies, including improvement of the corporate governance quality, shaping of requirements for the innovative component of their investment programs and improvement of the quality of examination of such programs by independent experts;
- Eliminating the barriers hampering innovative activity in the government regulation system (including technical, customs and fiscal regulation);
- Augmenting expenses associated with co-financing of the innovative projects of private companies (specifically through improved regulation of the venture capital industry, implementation of the project for supporting cooperation among businesses, education and science), as well as building work with government-owned companies aimed at developing and implementing their programs of innovative development;
- Expanding the support of development institutions for newly-established innovative companies;
- Implementing regional programs for small business support, as well as support for the implementation of specific projects under the relevant government programs and subprograms developed for high-tech sectors of the economy.

As of now, Russia has implemented a considerable scope of the above-mentioned activities. Currently the draft of the national strategy on science and technology till 2035 is being developed.

Government programs

The Innovative Strategy 2020 sets the global framework for the policy measures. However the success of every strategic document greatly depends on the quality of detailed plans and roadmaps aimed at its operationalization.

In order to implement the transparent and clear management system of the government budget the system of government programs was introduced. The government program is a set of policy measures and activities aimed at achievement of the key state priorities. There are currently 44 government programs grouped into 5 blocks: new quality of life, innovative development and modernization of economy, national security, sustainable regional development, efficient government.

The group "Innovative development and modernization of economy" include 18 government programs suggesting measures which will allow the Russian economy not only to keep its leading position on the global markets in the energy sector, mining and processing of raw materials, but also create a competitive knowledge-based economy and high-tech sectors. The creation of high-tech sectors is supported by development of an extensive transportation network which provides a high level of inter- and intra- regional integration and territorial mobility. More specifically, transformation of the national innovation system is covered by the government program "Economic development and innovation economy" and its subprogram related to the Skolkovo innovation center – "Creation and development of the Skolkovo innovation center".

Government program "Economic development and innovation economy" was developed by the Ministry of Economic Development. The government program includes 10 subprograms and one purpose-oriented program, every one of which provides a detailed plan of actions and measures related to some specific area of economic development and building innovation economy.

Overall the program sets the following goals and objectives:

- Creation of conditions for attracting investments into the economy of the Russian Federation;
- Development of a favorable competitive environment;
- Increasing in entrepreneurial activity and development of small and medium-sized enterprises;
- Eliminating excess regulation and undue state interference in the activities of businesses;
- Increasing the availability and quality of public and municipal services;
- Improving the efficiency of natural monopolies and the system of state regulation of tariffs;
- Development of the knowledge economy and high technologies;
- Improvement of government policy and the implementation of government functions in the sphere of land relations and real estate turnover, surveying, mapping and spatial data infrastructure of the Russian Federation;
- Improving the quality of state and municipal government;
- Improving the collection, processing and provision of statistical information.

The Skolkovo project is being developed under the subprogram "Creation and development of the Skolkovo innovation center", which was approved on August 2013. The subprogram implementation is coordinated by the Ministry of Finance, which is appointed an executive in charge. The subprogram is aimed at creation and development of the Skolkovo innovation center including achievement of the following objectives:

- creation and development of innovative environment in the territory of the innovation center "Skolkovo" which is favorable to the development of entrepreneurship and research in priority areas, and ensuring its harmonious functioning and development in accordance with the strategy of innovative development of the Russian Federation;
- development of autonomous non-profit organization of higher education "Skolkovo Institute of Science and Technology", designed to be a model of the new Russian technological university in terms of training and promotion of technologies to solve key scientific, technological and innovation challenges in the Russian Federation and throughout the world;
- creation of an innovation center, forming a research and social infrastructure, attractive to the constant influx of talent into it, and maintaining a favorable environment for innovation and commercialization.

The government has set the primary criteria for evaluation of the Skolkovo project efficiency. These include the amount of international patents and intellectual property registration applications, revenues of the participants, amount of private investments, terms of the market entry and the integral contribution of the project to the Russian economy. It is planned that by 2020 a successful, operational and effective innovative ecosystem and a platform for scaling the experience in operational management, innovation centers development and formation of the favorable conditions for studies development and commercialization will be created. Skolkovo will continue its active participation in the development of regional innovation clusters as optimal platforms for commercialization of developments. By 2020 the implementation of the subprogram will result in at least 50 operational centers of R&D, over 1,000 start-ups, a university of the world level and the necessary infrastructure creation in the framework of the Skolkovo project. The integral contribution of the project to the Russian economy will exceed RUB200 bn. by 2020, and RUB360 bn. rubles will be invested into the Skolkovo project by private businesses. The total amount of the budget financing allocated to the subprogram accounts for approximately RUB120 bn.

RUSSIA'S INNOVATION ECOSYSTEM

Role of the state

This section provides a review of the role of state in supporting innovation in Russia. More specifically it outlines the structure of state policy measures and activities of development institutions in regard to the four innovation archetypes mentioned above: science-based, engineering-based, efficiency-driven and customer-focused innovation. Support of these types of innovation requires use of a mix of instruments, including regulation measures and direct funding and could not be addressed without the government involvement.

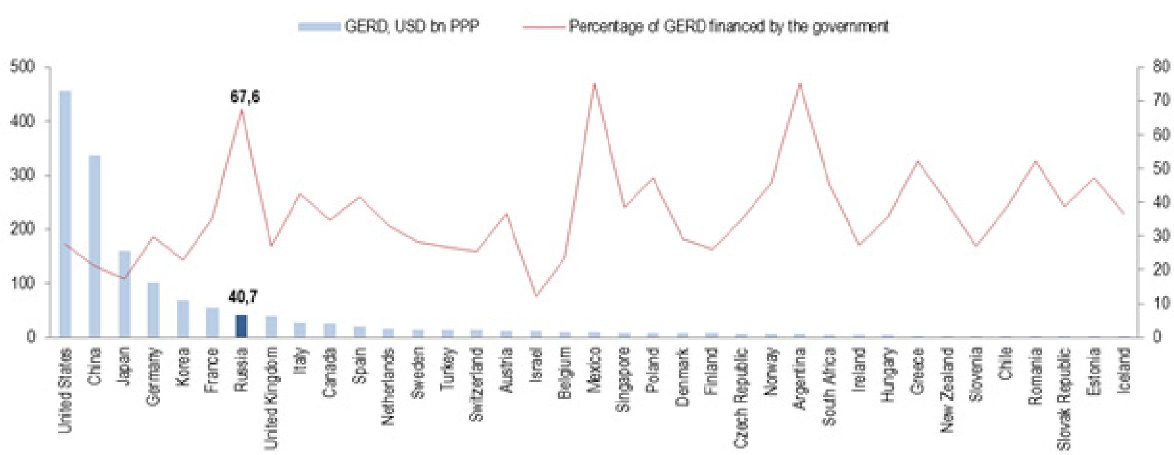
Generally speaking, the role of the state as an active participant in the innovation process is to create conditions for the emergence and commercialization of new technologies. The government may play a crucial role in shaping the performance of the national innovation system. And it is especially true for Russia.

The government is one of the key drivers of the innovation ecosystem development, and takes efforts in a number of directions:

- Direct financial support
- Indirect support through tax benefits
- Development of physical infrastructure
- Regulatory and administrative support and creation of framework conditions

In terms of direct financial support, the government plays a crucial role in financing of internal R&D expenses. Russia is one of the few countries which have government financed GERD over 60%, see the diagram prepared based on the OECD data below.

Exhibit 37 Government financed GERD, bn USD (PPP) and % of GDP, 2013



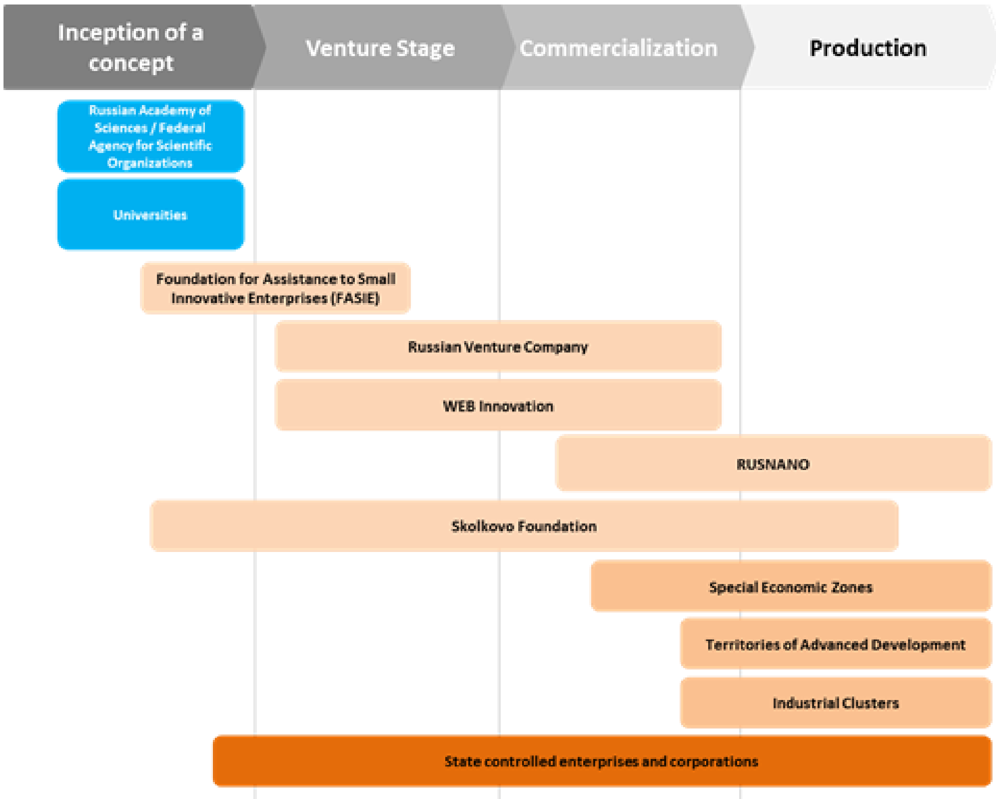
Source: OECD, Main Science and Technology Indicators(http://stats.oecd.org/)

Measured more broadly, the share of the state involvement is even higher and exceeds 80 percent of total financing, according to the review prepared by the analytical center under the Government of the Russian Federation[10].

Beyond the direct financial support of R&D, a wide array of public policies are implemented covering areas as diverse as education and training, competition and trade, as well as industrial and regional development. The state has developed a complex system of institutions designed to provide those support measures. The brief scheme of the Russia's innovation system from the state-centric point of view and key institutions are presented on a map below.

[10] *Annual monitoring of state financing of R&D expenses, Expert Center under the Government of RF*

Exhibit 38 State-centric view on Russia's innovation system: key institutions



Source: OECD, Main Science and Technology Indicators(http://stats.oecd.org/)

Inception of a concept stage is covered by the public research organizations and higher education institutions, which in total account for approximately 40 percent of the total R&D activities performed in Russia. They accumulate highly qualified research personnel and maintain global leadership in certain research areas.

Public research sector and higher education institutes

The public research sector comprises institutions of the academies of sciences and organizations focused on applied research. The sector accounts for approximately 30% of the R&D performed in Russia. This is a high proportion by international standards and reflects the separation of basic research from education in dedicated science academies which was inherited from the model adopted in the Soviet era. This distribution of activities is gradually shifting towards higher education institutions but this process may take significant time.

Table 18. Key characteristics of the government R&D sector

	2005	2010	2014
Total number of R&D organizations	1282	1400	1494
Total R&D personnel employed, thousand FTEs	272.7	259.0	263.8
% of total R&D personnel employed	28.8%	33.5%	36.0%
% of GERD on fundamental research	71.0%	79.3%	74.3%
% of GERD on applied research	28.4%	29.2%	34.9%
% of GERD on development	14.7%	13.8%	18.4%

Source: S&T Indicators: 2016, Data Book. The National Research University Higher School of Economics by the Government of the RF (Tables 5.2.1, 5.2.3, 5.2.5, 5.2.22)

The academia forms the core of the government research sector. There are over 870 R&D institutes, which employ around half of Russia's doctors of sciences and perform more than 50% of the country's basic research. The organizational structure consists of two major bodies – Federal Agency for Scientific Organizations (FASO) and academies of sciences, including Russian Academy of Sciences.

The Federal Agency for Scientific Organizations is a federal authority responsible for the legal regulation and provision of public services in the field of science, education, health and agriculture, as well as management of the federal property of the Russian Academy of Sciences, Russian Academy of Medical Sciences and Russian Academy of Agricultural Sciences. The agency was founded in 2013 in the course of transforming the Russian Academy of Sciences (RAS). The reform was run by the Ministry of Science and Education, and was formalized by the Federal Law №253 (September 2013).

By this time structural changes in the administration of RAS were certainly needed. The Academy due to its conservative structure inherited from the Soviet era turned into a large and inflexible body, covering vast functional including not only research and educational activities, but also administrative functions, property management, etc. The process of reforming the academic complex, including merger of the RAS, Russian Academy of Medical Sciences (RAMS) and the Russian Academy of Agricultural Science (RAAS) started in 2013 with the concurrent closing of their subsidiary science institutes and development of a new federal agency for managing the property of the three academies. This new federal authority was called the Federal Agency for Scientific Organizations (FASO). In the beginning of 2014 the Federal agency took control over 1000 of organizations, starting from research institutions to subsidiary clinics and kindergartens. After the transition of organizations, a large performance assessment of organizations has started and currently is under way.

The Russian Academy of Science is a federal body which governs fundamental and applied research activities. During the reform the RAS acquired the Russian Academy of Medical Sciences (RAMS) and the Russian Academy of Agricultural Sciences (RAAS). The RAS is organized by areas of science and territories and includes:

- 9 discipline-related divisions (mathematics, physics, chemistry, biology, life-sciences, etc.)
- 3 regional branches (Far Eastern, Siberian, Ural)
- 15 regional scientific centers (e.g. in Vladikavkaz, Kazan, Pushino, Samara, Saint-Petersburg).

The Siberian division of RAS was founded in 1957 and currently includes the scientific centers in Novosibirsk, Tomsk, Krasnoyarsk, Irkutsk, Yakutsk, Ulan-Ude, Kemerovo, Tymen and Omsk. The Novosibirsk scientific center is one of the key centers of the Siberian division, accounting for over 50% of the number of research organizations and personnel.

The Novosibirk scientific center is located in the city of Novosibirsk in a so called Akademgorodok (Academy Town). Akademgorodok hosts Novosibirsk State University, over 40 research institutes, technology park (Academpark), medical academy, apartment buildings and houses, and a variety of community amenities including libraries, stores, hotels, hospitals, restaurants and cafes.

The scientific centers of the Far East branch are located in Vladivostok, Khabarovsk, Petropavlovsk-Kamchatsky, Magadan, Blagoveshensk, Yuzhno-Sakhalinsk. The core of Primorie scientific center is located in Vladivostok. Since the mid-2010 the government initiated an ambitious program of developing a modern education and research center in Vladivostok to enhance the research and innovation potential of the region. Following this program a new campus of the Far Eastern National University (FENU) was opened on the Russky Island south of Vladivostok in fall of 2013 after its buildings hosted the 2012 APEC summit. Currently the university is a national leader in developing relations with Pacific Rim Countries. It develops more than 80 partnership projects, including 64 academic exchange programs with universities of the USA, China, Japan. The Skolkovo Foundation established a Far Eastern branch to cover the region. The branch is located on the campus of the FENU and supports high-tech startups in development and commercialization of their projects. The branch will attract and support startups as well as involve Russian and international companies in R&D and commercialization activities.

Higher education institutes (HEIs) account for approximately 9% of Russia's GERD, its share constantly increases primarily in applied research.

Table 19. Key indicators

	2005	2010	2014
Number of HEIs and % of total organizations (R&D)	539 (15%)	617 (18%)	775 (22%)
Total R&D personnel, thousand FTEs	43.5 (5%)	53.3 (7%)	62.3 (9%)
Researchers, thousand FTEs	30.0 (8%)	38.6 (10%)	44.3 (12%)
HERD, % of GERD	6%	8%	10%
Fundamental research	12.4%	14.2%	16.7%
Applied research	14.9%	19.4%	24.4%
Development	2.5%	3.7%	3.7%

Source: S&T Indicators: 2016, Data Book. The National Research University Higher School of Economics by the Government of the RF (Tables 5.1.1, 5.1.3, 5.1.11, 5.1.22, 5.4.22)

The HEIs sector is one of the fastest growing research sectors in Russia; its growth is stimulated by the government policy aimed at integration of education and research activities. The reasoning behind this policy is that academics, who are regularly involved in scientific research, can more effectively deliver contemporary knowledge on students, and especially graduate students. The new model of educational institutions is being implemented – one of them is Skoltech, which is developed basing on the MIT best practices.

Commercialization of research and development institutions

Russia is currently making steps to regain and enhance leading positions in theoretical and applied science. This ambitious goal requires systemic policies, aimed at developing human capital, improving research and development performance, building capacity in the high-priority areas, as well as launching a networking and cooperation mechanism between all actors of the innovation process, including scientific organizations, higher education institutions, development institutions, venture capital and business community. For the past decade the government has significantly increased the level of financing of civil science, the overall government financing grew more than 20-fold. But financing alone is not enough. Bringing new products, services and production processes requires both development and commercialization skills supported by transparent system of intellectual rights protection.

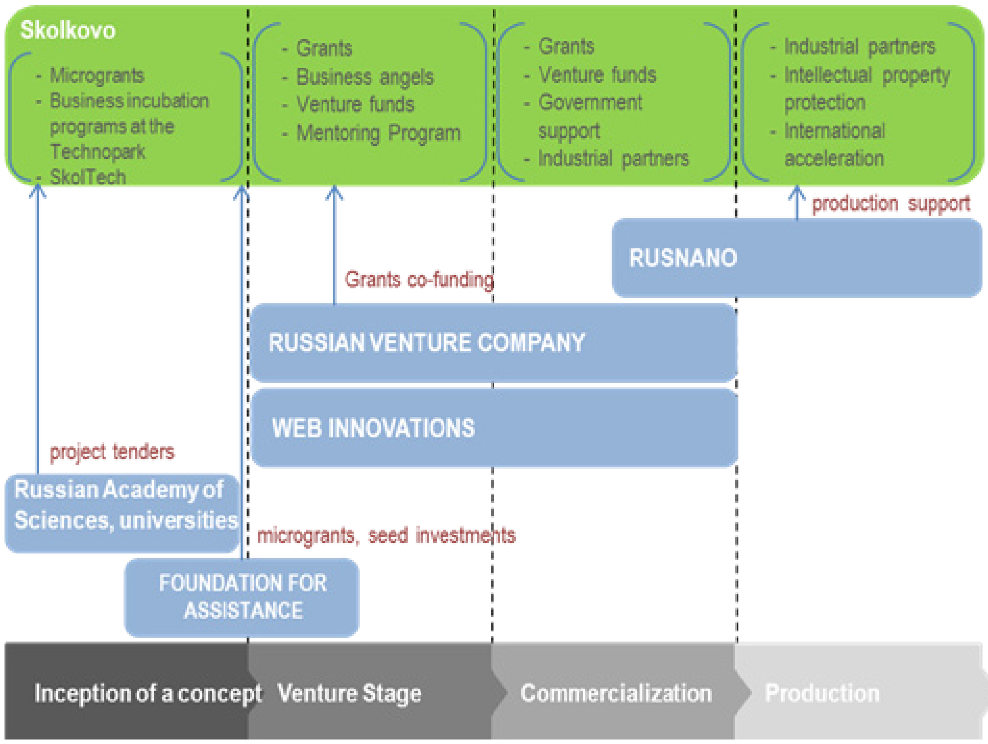
The modern world has faced a change in the innovation paradigm. The centrally planned innovation is transformed into widespread networking which allows companies to pursue more flexible research and development policy, and actively use the external knowledge, developed in universities, research institutions and start-ups. The "open innovations" approach gains popularity in the most dynamic industries, in which the developments' cost and implementation rate constantly grow as the technologies in use are becoming more complex and sophisticated. Typical examples of such industries are IT, biotechnology and pharmaceuticals. The position of innovation "suppliers" has been taken by higher education institutions and government-owned scientific organizations, capable of ensuring the ongoing inflow of new knowledge and developments with a considerable market potential. In developed countries, the transfer of technologies and other intellectual property created by universities and scientific laboratories is becoming increasingly important and larger in scale.

The government launched a set of development institutions to cover market failures and inefficiencies and foster building of commercialization capabilities of the national innovation system. The system of development institutions was designed so that an innovation project can grow stage by stage being transferred from one development institution to another. The definition of an "Innovation elevator" was later introduced in the government program Economic development and innovation economy (subprogram Fostering innovations).

The existing development institutions cover all innovative product development stages from an idea to entering the capital markets. The key structural elements of the "elevator" are Skolkovo foundation, Foundation for Assistance to Small Innovative Enterprises (FASIE), RUSNANO, RVC, Vnesheconombank (Russia's state-owned development bank, VEB), Russian bank for Small and Medium Enterprises Support (SME Bank), and the Foundation for the development of industry.

The system is supported by a number of regional venture funds, non-governmental organizations, Russian Venture Capital Association and Market of Innovations and Investment, a special-purpose trading platform of MICEX for high-tech companies.

Exhibit 39 System of Russia's development institutions



The Skolkovo project is a backbone of this system, as it is not only working with the existing projects and companies, but rather developing new ones. The sources of startups for the Skolkovo Foundation can include both the companies that are already part of the 'innovation elevator' system (e.g. those coming from the Foundation for Assistance to Small Innovative Enterprises in Science and Technology) and companies attracted to the Skolkovo ecosystem through mechanisms other than the innovation elevator. Development institutions play a critical role in building links between the Skolkovo ecosystem and the community of tech startups in Russia. The 'Innovation elevator', a system of comprehensive support for promising projects at different stages of development, is a key mechanism ensuring the integration and coherence of the ecosystem.

Skolkovo Foundation and Skolkovo innovation center project

The purpose of the Skolkovo project is to create an ecosystem facilitating the development of entrepreneurship and research in 5 priority sectors of the national economy: energy efficiency and conservation, strategic computer technologies and software, medicine technologies related to medical equipment and medication development, space and nuclear technologies.

The first official milestone of the project is adoption of the Federal Law 244 related to the Skolkovo innovation center which was issued on September 2010. The Federal Law declared the mission of the project, its mandate and benefits to participant companies. According to the Law the Skolkovo Foundation was appointed a management company of the project.

Researchers and entrepreneurs, businessmen and industrial companies, venture investors and business angles, all of them brought together within the framework of this innovation eco-system, are working on the task of creating successful and competitive world-class projects.

The nucleus of the eco-system is made up of technological start-ups, researchers, industrial companies, investors, and mentors. To ensure a friendly environment for the interaction of all of the above elements, three types of infrastructure are being created: an educational infrastructure – the Skolkovo Institute of Science and Technology; a service infrastructure – an entire complex of services, from laboratories to support and assistance with intellectual property protection, which Technopark is providing in conjunction with the Skolkovo Intellectual Property Center; and, finally, a physical infrastructure designed to secure an optimal environment for research and business, while maintaining an attractive and productive urban habitat, equally convenient both for the innovation center residents and for its guests.

Bringing together all of the eco-system elements on the Skolkovo premises helps to achieve a breakthrough synergistic effect.

Technology start-ups in Skolkovo are small high tech companies that have been selected by a panel of experts awarded the Skolkovo participant status. The decisions to award the participant status and to extend grants are made by an independent expert community, which brings together over five hundred of prominent experts in relevant fields members of the Russian Academy of Sciences and the Russian Academy of Medical Sciences. Experts on the Scientific Advisory Council are also involved in identifying investment priorities, which serve as guidelines for attracting start-ups. More than half of the Scientific Advisory Council members are also members of the Russian Academy of Science.

Industrial companies in Skolkovo are represented by more than 60 leading Russian and international companies, leaders in their respective sectors. Industrial partners integrate the research environment and the business environment of the Skolkovo innovation eco-system, serving both as a source of commissions and orders and as consumers for the innovative solutions generated by the start-ups. The R&D Centers set up by Skolkovo's industrial partners play a crucial role in the development and testing of the new technologies, as well as in the integration of innovative ideas into final products and solutions.

Professional institutional and private investors – venture funds and business angels – are a key element of the Skolkovo eco-system. Business angels provide technological start-ups with an opportunity to attract investments at the earliest stage of their life cycle – at the stage where the lack of venture capital in Russia is particularly marked; this stage is commonly referred to as the "valley of death". Currently, more than 40 funds and more than 200 business angels are part of the eco-system.

The Skolkovo Institute of Science and Technology has started its operation on the premises of the Skolkovo Innovation Center. Skoltech represents a type of higher education institution that is completely new for Russia and combines science and innovations. The University, which was established as part of the Skolkovo eco-system and may become an economic growth engine for Russia, has brought together within its walls Russian and foreign talents, business partners and a first-rate infrastructure.

The Skolkovo innovation center development strategy by 2020 was approved at the end of 2012. Furthermore the development strategy was reflected in the state subprogram 'Creation and development of the Skolkovo Innovation Center', which became a part of the state program Economic Development and Innovation Economy. The strategy assumes three key stages of the innovation center development:

- Creation and generation of a critical mass of the key elements of the innovation ecosystem (2010 – 2012)
- Improvement of the quality of the key elements of the innovation ecosystem, including the development and implementation of retention and attrition mechanisms, and ensuring of integration and interaction between the elements (2013 – 2016)
- Transition to self-development, promotion of the commercialization potential of the innovation ecosystem (2017 and further on).

The activities of the first development stage were successfully completed and resulted in the following achievements: a community of tech startups was created, industrial partners and investors were engaged, and the development of physical and service infrastructure of the innovation center started. The first quantitative milestone was reached in 2013, when the number of startups exceeded 1000. Currently more than 1500 startups which employ over 18,000 FTEs, participate in the Skolkovo project. Their total revenue for 2013 – 2015 accounted for over RUB 80.5 bn, total private investments for 2013 – 2015 went beyond RUB 13.5bn.

In the new context, the key goal for this stage is to accelerate the development of internal links between the elements and enhance cooperation within the ecosystem. As a rule, global innovation centers had much more time to develop their ecosystems and did not face many challenges at the initial stage of development, thus being able to let their ecosystems develop more spontaneously.

The current agenda dictates that the Innovation center should be more actively involved in the development of the connections between elements of the ecosystem. Achieving this goal requires activities to attract new and intensify the cooperation with the existing industrial partners, building a sustainable investment community and success stories of investments in tech startups, and a targeted approach to startup acceleration using all the capabilities of the physical and service infrastructure, as well as of the international partner network of the Innovation Center. Targeted acceleration of innovative projects is of key importance, as it builds a strong commercialization potential. In an unfavorable environment, the cost of mistake at the start of an innovative project increases multifold, while acceleration will increase the share of startups able to pass through the 'death valley'. Integration of Skolkovo to the Russian innovation ecosystem and international ecosystem interaction is an important goal as well.

The Foundation and development institutions cooperate in the following areas: cross-membership in governing bodies, regular activities in the field of innovative and educational projects, promotion of science and innovations in Russia.

Foundation for Assistance to Small Innovative Enterprises (FASIE)

The Foundation for Assistance to Small Innovative Enterprises (FASIE) was founded in February 1994 in order to encourage SME to carry on R&D in conditions of economic crises and vast decrease of S&T financing. The mission of the Foundation is to support companies with seed capital for transforming their ideas into industrial prototypes and then into commercial product.

Main priorities of the Foundation are to support the programs that involve young people in innovative activity; seed financing; and to assist the development of the export oriented SMEs and strengthen international cooperation. The Foundation acts as the first floor of the innovation elevator, providing financing and support at the pre-seed and seed stage.

For the last two decades, the Foundation has received more than 45,000 applications for R&D projects and concluded more than 12,000 contracts with small innovative enterprises from 75 regions of Russia, including more than 700 spin-offs of the research institutions. The Foundation has supported more than 10 000 young innovators, created more than 4 500 startups. Currently the Foundation runs a network of 68 representatives in the regions of Russia.

The program "Umnik" sets the goals to attract young people to the field of science, technology and innovation. This program provides financing of RUB 500,000 (USD 7.5k) for 2 years to young people (aged 18 – 30) in the following areas: IT, medicine and pharmacology, new materials and technologies, new devices and instruments, biotechnologies.

The program "Start" is one of the most popular and important support programs since its inception in 2004. It occupies the niche of seed finance of the projects with a high potential towards commercialization. The program is designed so that the firms receive support during three years with the transition to the second and the third year carried out on a competitive basis. On the first year a permanent loan is given and later the company is assumed to switch to self-financing or co-financing (with the Foundation or an external investor). The overall financing provided amounts to RUB 5 mn per participant, which is staged in 3 periods. More than 19 000 companies and teams took part in the program, it resulted in creation of over 5000 startups.

The program "Development" (Razvitie) is focused on assisting SMEs in developing the technologies and growing the market share. The program is offered to the companies experienced in R&D, with a proven financial history and in possession of the intellectual property rights on the technology involved in the project. The Foundation covers 50% of the costs of the R&D work but not more than RUB 15 mn.

The program "Internationalization" supports SMEs entering foreign markets together with the business development institutions from Germany, Finland, France and other countries. The program instruments include project financing, education programs and export support.

The Foundation also provides support to cooperation between high-tech SMEs and large business (the program "Cooperation"). The program supports SMEs selected upon a competition to deliver R&D contract signed with the competition sponsors (large business companies). The amount of financial support is limited to RUB 20 mn (for 24 months). The FASIE main body consists of several departments, headed by the Direction Board and the general director. The Direction Board is the principle executive and managing body of the Foundation. Its members are the general director, deputy-directors and heads of the departments.

Functions of control and coordination are held by the Supervisory Board of FASIE which includes representatives of the Ministry of Education and Science, the Ministry of Economic Development, the Ministry of Finance and other governmental bodies and committees. The Foundation cooperates in total with over 2400 independent experts, from whom more than 700 have PhD degree.

Russian Venture Company (RVC)

RVC is a development institution, which acts as a government fund of funds. The Company was established in June 2006. The main purpose of RVC is to promote creation of Russia's own venture investment industry and significantly increase financial resources of venture capital funds. The company's role is to be a state fund of venture capital funds and a vehicle for state promotion of venture investing and financial support to the high-tech sector as a whole. It is also a state institution for development of the venture investment industry in the Russian Federation.

Since 2015, RVC has been defined as a project office for implementation of the National Technology Initiative (NTI) - the long-term strategy of the country's technological development, aimed at formation of new global markets by 2035. The mission of the company is to increase the volume, accelerate the growth, and adjust the areas of development of the venture capital market of the Russian Federation with the aim of improving the competitiveness of the innovative sector of the country's economy globally. The authorized capital of the company accounts to RUB 30 bn (about USD 450 mn) is 100% owned by the Federal Agency for State Property Management.

Investment activity of RVC is aimed at involving private Russian and foreign players in innovative segments of the Russian economy and development of new investment instruments of the national venture capital market. This activity is carried out through establishment of funds based on public-private partnership. RVC is focused on knowledge-intensive high-risk industrial sectors with low presence of private capital, which is essential for the country's balanced innovative development and for promising interdisciplinary segments. Another priority of RVC's investment activity is creation of RVC seed and pre-seed funds.

The priority areas for investment by RVC-funded venture capital funds have been determined in accordance with the Essential Technology List approved by the President of the Russian Federation, which includes the following: security and counter-terrorism actions; living systems (understood as biotechnology, medical technology, and medical equipment); industry of nanosystems and materials; information and telecommunications systems; sustainable environmental management; transport, aviation, and space systems; power engineering and energy efficiency. RVC invests through venture capital funds created in conjunction with private investors. The total number of RVC funds has reached 23, with their total size of RUB 33.7 bn., i.e. about US$ 520 mn.

RUSNANO

RUSNANO implements state policy for the development of the nanotechnology industry in Russia, acting as a co-investor in nanotechnology projects, which have substantial economic or social potential. The mission of RUSNANO Group is furthering public policy to win a leading role for Russia on world markets for nanotechnologies. This mission dictates the main tasks of the Group: coordinating innovation in the field of nanotechnology and bringing Russian nanotechnologies to market. The Group's goal is to build a competitive nanotechnology industry based on the advances of Russian scientists and the transfer of cutting edge technologies from other companies. The Group dates its history back to 2007. Initially it was established in the form of the state corporation under the Federal Law (July 2007). The government of the Russian Federation made a statutory contribution in the amount of RUB 130 bn. In 2010 the state corporation was reorganized into a number of entities (Rusnano Group).

The Group includes the following companies: Rusnano JSC, Rusnano Management Company LLC, Fund for Infrastructure and Educational Programs and two subsidiaries for operations on foreign markets – Rusnano USA and Rusnano Israel. Rusnano JSC supports the implementation of state policy for development of the nanotechnology industry by investing directly and through nanotechnology funds in financially efficient high-tech projects, facilitating the development of new industries in Russia. The key areas for investment are: electronics, optoelectronics and telecommunications, healthcare and biotechnology, metallurgy and metal goods, power engineering, machine-building and device manufacturing, construction and industrial materials, chemicals and petrochemicals. All of the shares of Rusnano are in state ownership. The asset management functions are exercised by Rusnano Management Company LLC, created in December 2013 with Anatoly Chubais as Executive Chairman. The Fund for Infrastructure and Educational Programs was created by Federal Law № 211 "On the reorganization of Russian Nanotechnologies Corporation" (dated 27 July, 2010). The task of the Fund is to create innovative infrastructure for the nanotechnology industry, including development of educational and infrastructure programs, which were initiated by RUSNANO.

Innovation ecosystem of Russia: role of the business

It is a widespread belief that the Russian business is reluctant to embrace innovation. In this section we will assess if it is really true or not. First of all, we use the general statistics, but decompose the average indicator by size of enterprises. The table below demonstrates that the detailed picture is more difficult as it is shown by the average indicator. Low level of involvement in innovation is more typical for SME sector which is large in numbers and influences the average figures. The large business companies demonstrate relatively high engagement level.

Table 20. Innovation activity of private enterprises, % involved

Distribution per FTE	Level of innovation activity, %	Enterprises engaged in		
		Technology innovation	Marketing innovation	Organization innovation
Total	**10.1**	**8.9**	**1.9**	**2.9**
200-249	13.6	12.3	2.6	3.1
250-499	17.2	14.9	3.5	4.5
500-999	27.0	24.4	5.6	8.1
1000-4999	44.5	41.9	9.9	15.7
5000-9999	72.3	70.0	11.9	36.
10 000 and over	75.5	73.5	18.8	46.9

Source: Indicators of innovation in the Russian Federation, 2016. The National Research University Higher School of Economics by the Government of the RF (Table 2.4)

Russia's companies are developing international connections and involved in joint R&D projects with foreign companies.

Table 21. Share of organizations performing joint R&D projects in the total number of performers of technology innovation

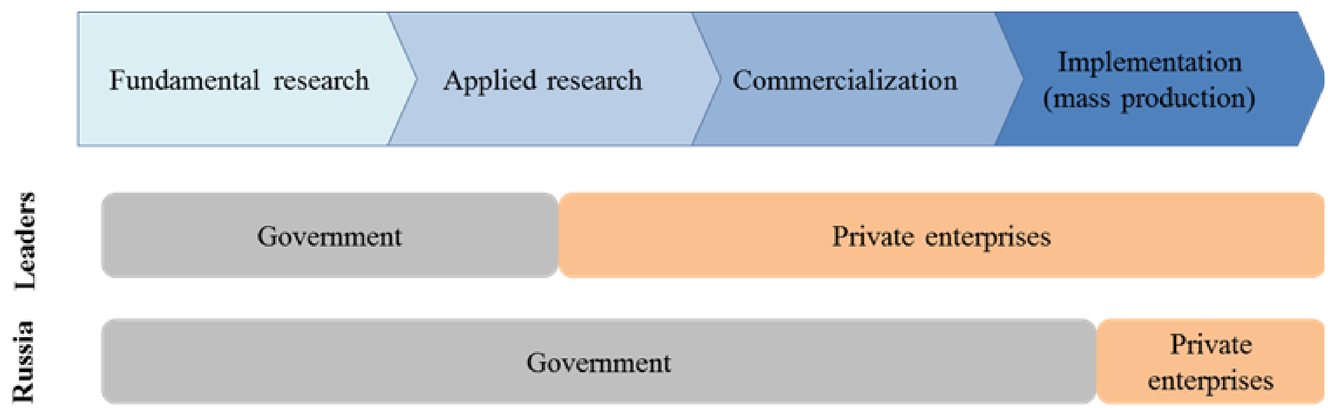
	Total	EU Countries	USA	India and China
Russia	**36.0**	**6.6**	**2.3**	**2.5**
Austria	43.0	27.9	7.3	3.7
Belgium	52.2	30.5	7.8	4.3
Germany	23.7	6.9	2.1	1.5
Denmark	42.8	24.5	8.6	6.0
Ireland	31.2	19.5	10.5	3.7
Spain	29.3	8.0	2.0	1.1
Italy	12.7	4.1	0.7	0.7
Netherlands	33.6	10.5	10.4	4.9
Norway	28.1	15.6	6.1	2.5
Poland	31.3	15.8	3.7	1.9
Turkey	17.2	5.1	1.6	1.5
Finland	36.1	24.7	9.7	5.3
France	34.8	14.0	4.8	2.4
Sweden	30.1	20.6	10.4	6.0

Source: Indicators of innovation in the Russian Federation, 2016. The National Research University Higher School of Economics by the Government of the RF (Table 2.4)

However the level of international cooperation and more specifically cooperation with China has still a large potential to be uncovered. As we have previously mentioned, the business sector is actively involved in technology update and business process optimization. In terms of innovation archetypes, technology innovations can be attributed to the engineering-based and efficiency-based

innovation, organization innovation is related to efficiency-based and marketing innovation to consumer-focused innovation.
But what did this belief of the Russia's business low involvement potential stems from? The usual value chain of innovation implies linked chains, but in case of Russia the chain is disrupted as inventions, generated in the national system are not easily put into commercialization and production.

Exhibit 40 Comparison of innovation development chains, Russia vs leading countries



The business is mainly acquiring ready-for-use products and technologies. Statistics indicate that the technology transfer is in general inbound. The number of organizations engaged in inbound technology transfer is approximately 6-10 times higher, than those engaged in outbound distribution of technology.

Table 22. Technology transfer: structure and country distribution

	Manufacturing, processing, generation of gas, energy, water		Telecommunications and IT	
	Inbound transfer	Outbound transfer	Inbound transfer	Outbound transfer
Percentage of the total number	28.4	2.5	26.1	9.4
% inside Russia	63.8	73.3	69.8	80.6
% with CIS countries	4.9	16.7	0	9.7
% foreign countries	31.3	10.0	30.2	9.7

Source: Indicators of innovation in the Russian Federation, 2016. The National Research University Higher School of Economics by the Government of the RF (Tables 1.9)

New technologies have not reached the critical mass, quantity of acquired technologies has not yet fully transferred into quality of innovative products.

Table 23. Share of innovation products, % of total amount

Industry	2007	2013
Russia	4.6	9.2
Austria	10.6	11.9
United Kingdom	13.9	5.2
Germany	17.6	15.5
Ireland	10.1	9.3
Norway	7.2	6.1
Poland	13.5	8.0
Finland	14.9	15.3
Sweden	13.4	8.4
France	11.7	14.7

Source: Indicators of innovation in the Russian Federation, 2015. The National Research University Higher School of Economics by the Government of the RF (Table 8.9)

The government support of innovation activities has gradually improved the situation of innovation involvement. Based on the results of information survey conducted by the Expert Center under the Government of the Russian Federation, 60 percent of respondents indicated that the government support has changed things for the better.

Table 24. Information survey, positive changes

Results	Respondents indicated results achieved	
	Private enterprises	State-owned enterprises
Finished R&D project	61%	69%
Launched new product	53%	46%
Increased sales or market share	29%	15%
Increased export sales	8%	3%
Increased profit margin	10%	2%
Decreased costs on energy	7%	6%
Decreased costs on raw materials	5%	2%

Source: Innovative strategy 2020: assessment of development, Expert Center under the Government of the Russian Federation

Current economic transition will foster transition of enterprises towards innovation agenda, as it is the only way for them to face economic challenges and remain competitive. It is the Russia's SME sector that is to drive the transformation of the economy.

Role of venture investors

The market for venture investments began its history in the early 1990s. Privatization of industrial enterprises promoted the emergence of an equity investment market, and foreign investors could access the Russian market when some trade and financial barriers were removed. The first regional venture funds was established by the EBRD, which launched 11 regional funds in Russia with capital ranging from USD10m to USD30m. In March 1997, the management companies of 10 out of the 11 EBRD investment funds operating in Russia at that time signed an agreement establishing the Russian Venture Capital Association (RVCA). The RVCA became the first professional association of Russian investment funds to declare the objective of establishing and developing an equity and venture investment market in Russia. In 2005, Russia's Ministry of Economic Development (MOED) realized the program for the establishment of regional investment funds to support VC in small R&D companies. Within the program over 20 public-private VC funds in different regions have been established. OJSC Russian Venture Company (RVC) was established by a government directive in 2006, and the investment funds of the MOED were placed under its control.

The Russian Government plays a significant role in developing the innovation economy in Russia. At the early stages of the history of the Russian VC market, particularly in 2004–09, the Government set up several innovation-oriented institutions (RVC, Rusnano and Skolkovo) that catalyzed and endorsed the interest in the new economy, in innovations and in entrepreneurship in both the society and the business community. At the same time, significant efforts to make the tax environment friendlier for new businesses were made. A batch of incentives was introduced, such as the special tax status of Skolkovo residents, VAT exemption for software licensing, reduced social security rates for IT companies and others. These changes were acknowledged both by local business and foreign investors.

The key government development institute responsible for venture market development is RVC. The RVC has played a substantial role in development of the venture market in 2007 – 2010, but by 2013 – 2014 its role decreased significantly due to the growth of the market.

Though the venture market faced substantial growth and availability of financing in some industries, such as IT has increased, the Government still accounts for most investments made into the capital-heavy segments, such as energy efficient technologies and new materials and plays an important role there by supporting qualified specialists and the level of expertise. Private investors are not yet ready to invest in the sophisticated and innovative segments of the economy that do not guarantee positive financial exits. By doing this, the Government executes its social functions and allows innovative companies to develop early stage products in such a way that they will be suitable for private funding at the later stages of their development.

Since the mid-2014 the venture market faced significant decline in terms of business activity and volume. As of 2015 the total capital has dropped by approximately 10 percent and reached USD 24.7 bn vs peak value of USD30.5 bn[11]. It was severely affected by the unstable economic situation, including volatile currency rate and sanctions imposed on Russia. The country faced a remarkable capital outflow followed by decline in investment rating which led to decline in investment activities of many foreign funds. The role of government has significantly increased as funds with the state participation account for 74 percent of new capital acquired, 24 percent of investments and 43 percent of exits.

[11] *Russian Venture Capital Association, Russian PE and VC market review, 2015*

RUSSIA'S INNOVATION INFRASTRUCTURE: SPECIAL ZONES, CLUSTERS AND TECHNOLOGY PARKS

The Russian innovation infrastructure is comprised of special zones, high-tech clusters and technology parks. The government passed a number of laws in order to support collaboration between companies, especially startups and small innovative firms and universities; establish a legal framework for the innovation centers to encourage R&D by entrepreneurs; and set up special economic zones that allow more of a free market approach to developing business and to allow easier attainment of foreign talents.

Special Economic Zones

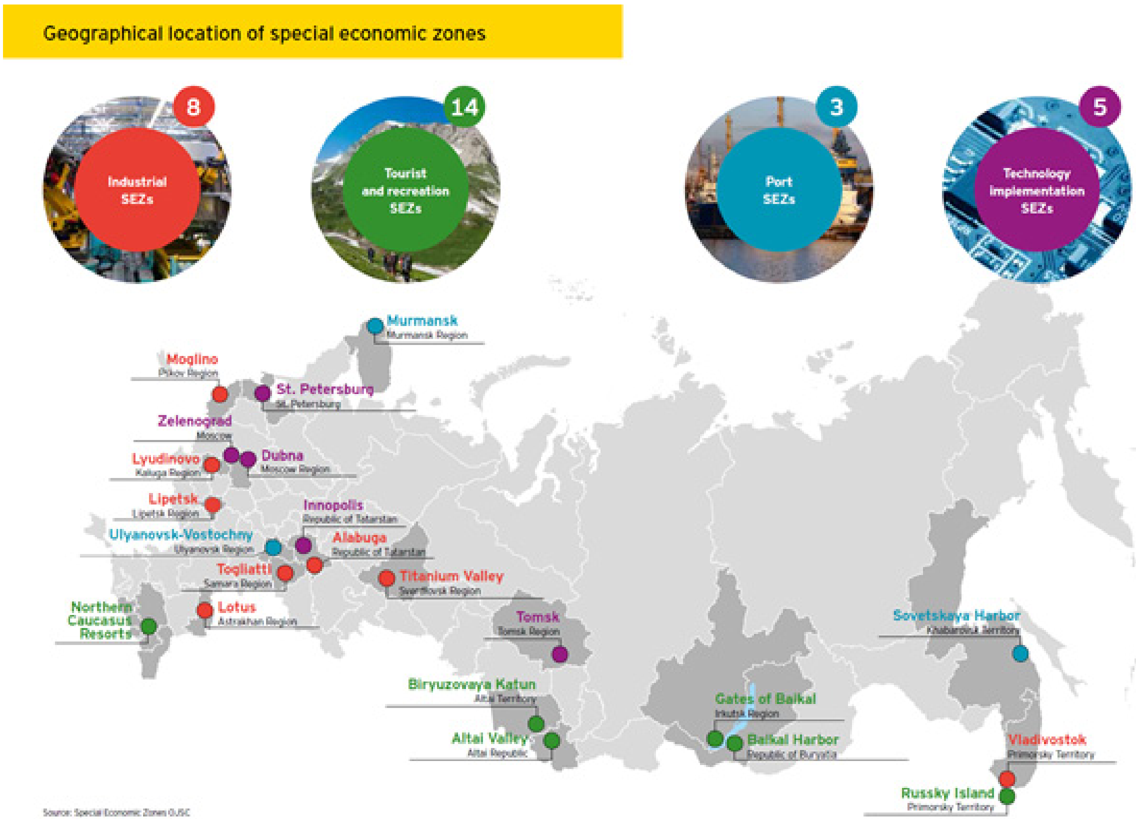
Development of special economic zones is a traditional way of setting up infrastructure for economic development. Special economic zones act as growth points attracting critical mass of innovative firms, providing necessary facilities and infrastructure for R&D and production. Special economic zones are of special importance for engineering-based and efficiency-based innovations, as they facilitate knowledge transfer, accumulation of know-how and development of sophisticated research and manufacturing ecosystem networked to the global markets. In international practice, these areas usually receive special support on the state and local level in the form of provision of the infrastructure needed for launching production, preferential tax, customs and administrative regimes, favorable to the zones' residents.

In Russia a special economic zone (SEZ) is an area with a special legal status and economic benefits designed to bring Russian and foreign companies into priority sectors of the Russian economy. SEZs are formed under a federal program overseen by the Russian Ministry for Economic Development (Federal Law No. FZ-116 of 22 July 2005). The government has launched a dedicated state management company Special Economic Zones OJSC (SEZ OJSC) which manages the majority of SEZs and is responsible for recruiting and assisting resident companies. In regions, SEZ OJSC is represented either by branches or by subsidiary joint-stock companies. Current law envisages four types of special economic zone: innovation, industrial, port, and tourist and recreation. Resident of a special economic zone is a commercial organization (or also an individual entrepreneur in case of an innovation zone) which is registered in an SEZ municipality and has signed an agreement with the SEZ management company and the Russian Ministry for Economic Development to carry out activities appropriate to the type of SEZ in accordance with the procedure and on the terms, provided in Federal Law No FZ-116.

The four existing Innovation Zones are situated in Tomsk, St. Petersburg, Moscow, and Dubna, Moscow Region, which are famous as major centers of science and education with long-standing scientific traditions and recognized research schools. The innovation priorities of the innovation zones are nano and biotechnologies, medical technology, electronic and telecom equipment, information technology, precise and analytical instruments, nuclear physics. A set of customs and tax privileges and access to professional personnel resources combined with growing demand for new technologies and modernization of various sectors of Russian economy make the Innovation Zones attractive for venture funds and developers/manufacturers of technology-intensive products.

The Industrial Zones are located in the Yelabuga District of the Republic of Tatarstan and the Gryazi District of Lipetsk Region. On August 12, 2010, the Russian Government signed a decree establishing an Industrial Zone in Samara Region in immediate proximity to Tolyatti. Industrial zones are designed to help companies reduce cost through proximity to production resources, access to existing infrastructure and key thoroughfares. The industrial zones' priorities include motor vehicles and components, construction materials, chemicals and petrochemicals, household appliances and retail equipment.

Exhibit 41



Source: Russia's industrial and innovation infrastructure, EY

Territories of advanced development

The Russian government has decided to fully utilize experience gained upon development of special economic zones and introduced a new type of an economic zone – a territory of advanced development. In his address to the Federal Assembly on December 2013, the Russian President Vladimir Putin proposed that a network of advanced development zones be created in the Russian Far East and Eastern Siberia, providing special conditions for non-resource production, especially for export oriented one. These zones would create 'business conditions competitive with key business centers in the Asia-Pacific Region', including simplified procedures for obtaining construction permits, power grid hookups, customs clearance, etc.

The legal framework was introduced by the Federal Law No 473-FZ "On Advanced Development Zones in the Russian Federation" which was issued in December 2014 and took power in March 2015. It sets a special legal regime, defines the measures of state support and regulation of activities within the territories. The territories are funded by the federal, regional and local budgets, as well as from non-budgetary sources.

The resident's benefits include the reduced social tax rate, zero VAT rate on import for processing, zero rate on import and export customs duties, reduced rates of profit, property and land taxes. Residents receive free access to land and infrastructure, improved administrative regulation and many other benefits.

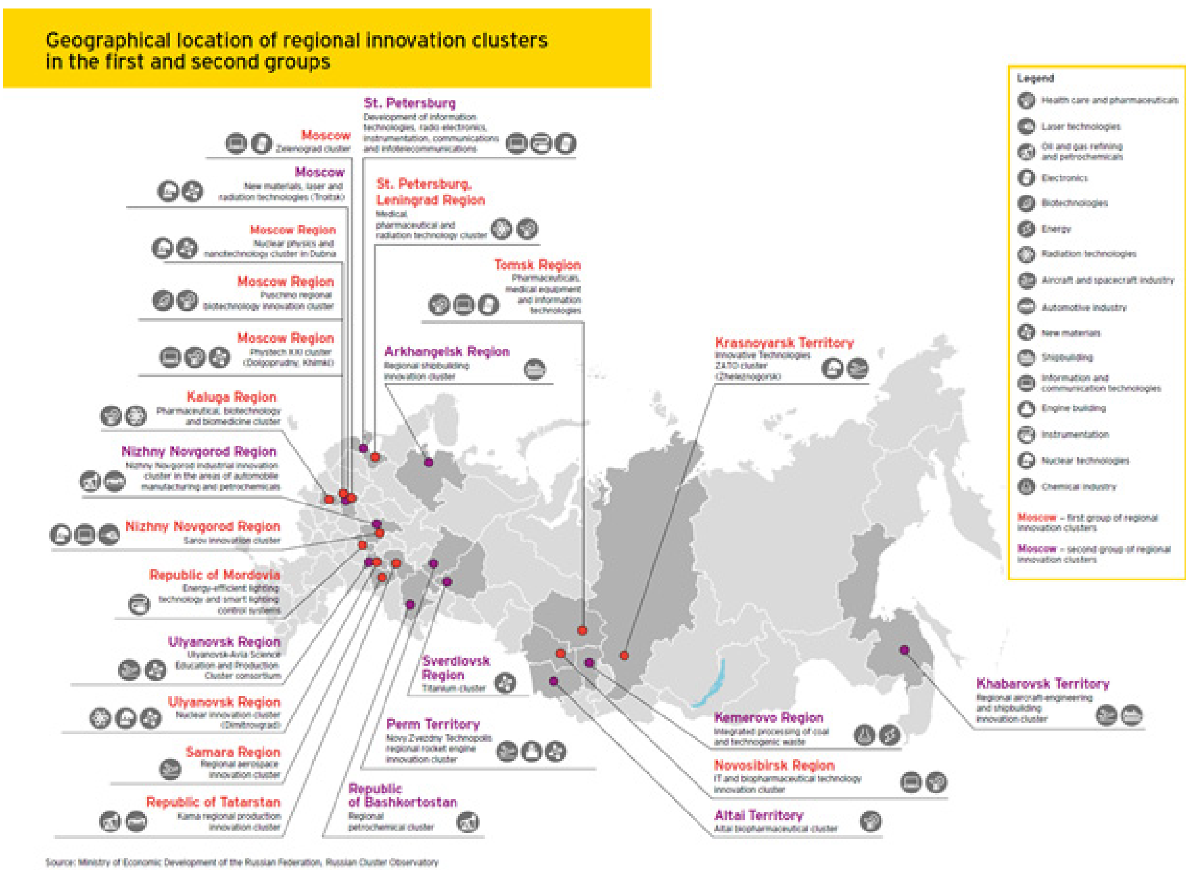
The target areas for developing include Amur region, Primorie region, Khabarovsk region, Yakutiya, Kamchatka and Chukotka. There are three zones currently located in Primorie region: Nadezhdinskaya, Khabarovsk and Komsomolsk. The Nadezhdinskaya project involves the creation of an investment site with a total area of over 800 ha, complete with road and utility infrastructure. Target residents are investors with projects in the areas of machine building, food, pharmaceuticals and light industry as well as building materials and production logistics. The site of Khabarovsk advanced development zone is to have a number of investment projects that are largely industrial in nature (metallurgy, construction, and food products). The Komsomolsk zone is located in the vicinity of Komsomolsk-on-Amure and Amursk cities and occupy over 200 ha. The industrial profile of the zone is aircraft engineering and woodworking.

Regional innovation clusters

Regional innovation clusters comprise business, education and science under the support of state and local authorities. Networking and cooperation between cluster's participants provide for synergy and enhances the competitiveness of a cluster's output.

Russia's legislators have made active use of cluster initiatives over the past few years to make the national economy more competitive. In August 2012 the Russian Government approved a list of 25 pilot regional innovation clusters. The following areas of technology have been selected for development of clusters: nuclear and radiation technologies, production of aircraft, spacecraft and ship building, pharmaceuticals, biotechnologies and medical devices, new materials, chemical industry, IT, telecommunications and electronics. Currently there are 25 approved clusters, which are largely located in areas with a high concentration of scientific, technical and manufacturing activity.

Exhibit 42



Source: Russia's industrial and innovation infrastructure, EY

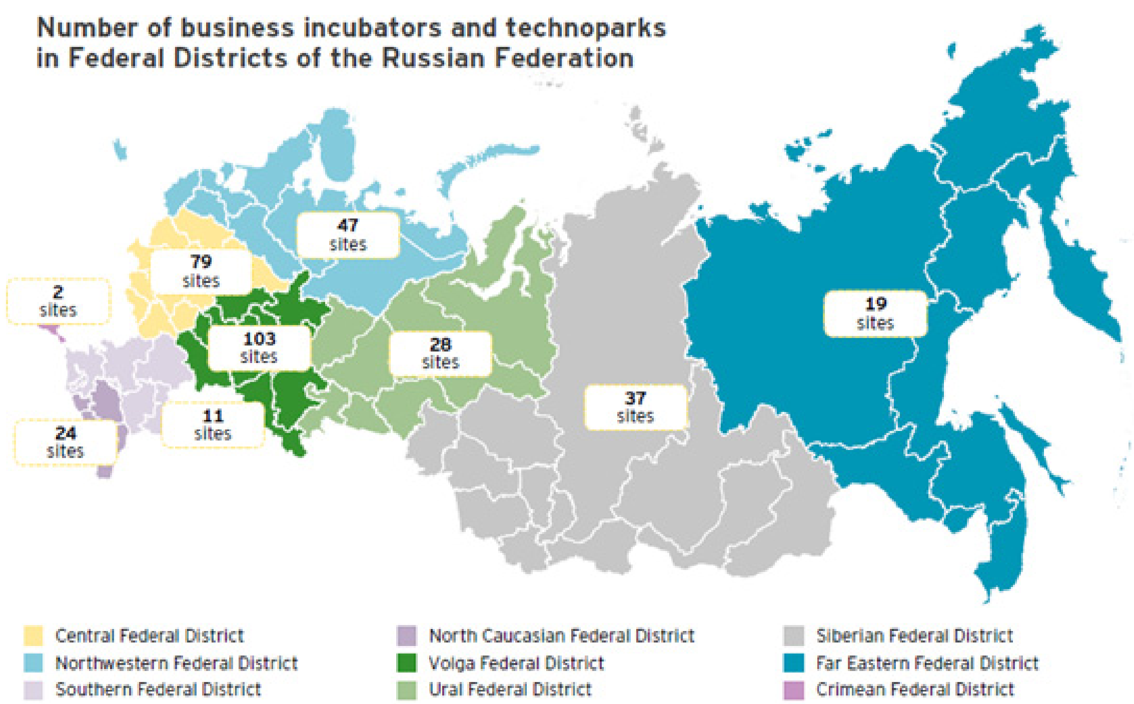
Infrastructure: technology parks and ITCs

In this section we provide a brief overview of the Russian technology parks and innovation and technology centers (business incubators). Technology parks and ITCs are the important elements of the innovation ecosystem providing necessary physical and service infrastructure to startups and SME.

The first Russian technopark was founded in 1990 in Tomsk (Tomsk science and Technology Park). In the following years the number of technology parks was growing at a significant rate, currently there are approximately 100 technology parks in Russia.

The map below provides information on the regional distribution of Russian technology parks and business incubators. Over half of the sites are located in the Volga and Central federal districts. The Central Federal district is a leader in terms of the total number of technology parks (41), Volga Federal District has the most business incubators (75).

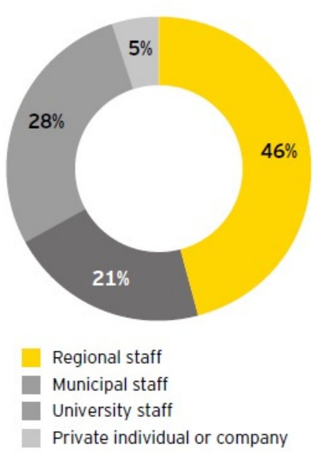
Exhibit 43



Source: Russia's industrial and innovation infrastructure, EY

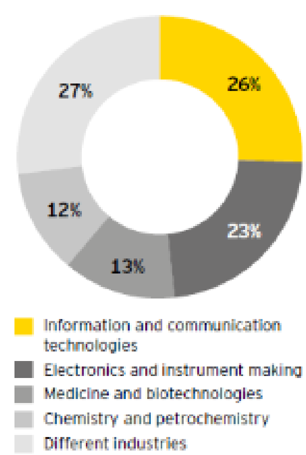
Based on the research collected by EY and presented in research *Russia's Industrial and innovation infrastructure*[12] the majority of technology parks are operated under the auspices of regional or municipal authorities. Over a quarter of our respondents operate under the auspices of institutions of higher education.

Exhibit 44 Distribution per type of ownership



Source: Russia's industrial and innovation infrastructure, EY

Exhibit 45 Industry specialization of the Russian technology parks



Source: Russia's industrial and innovation infrastructure, EY

Most of the technology parks are located on the university campuses and on the premises of research institutions; however the most commercially successful technology parks cooperate with the industrial corporations.

The majority of the Russian technology parks specialize in high technologies, with over 25% focusing on IT and telecommunications (including data processing, storage and analysis, computer technologies and telecommunication systems). Approximately 25% are specializing on electronics and instrument making, 13% in medicine and biotechnologies.

[12] *Russia's industrial and innovation infrastructure, EY, 2015*

The Russian technology parks formed an association called "Association of clusters and technology parks". The association was founded in 2011 and currently includes more than 40 members. The key members are Technopolis Moscow, Technopark Skolkovo, Technopark Mordovia, Novosibirsk Academpark.

The Ministry of Telecom and Mass Communications of the Russian Federation implemented a government program on development of technology parks, which support the key 12 technology parks selected for participation: Technopolis Khimgrad Kazan (Kazan), Academpark (Novosibirsk), IT-park (Kazan), IT-park (Naberezhniye Chelny), West-Siberian Innovation Center (Tyumen), Technopark Kuzbass (Kuzbass), Technopark Mordovia (Saransk), Technopark Rameev (Penza), IT-park Ankudinovka (N. Novgorod), Technopark Zhigulevskaya Dolina (Togliatti), Phystechpark (Moscow), University technopark (Yekaterinburg).

Based on the recent survey, conducted by EY (Russia's industrial and innovation infrastructure),

Russian technology parks and IASP

IASP is the worldwide network of science parks and areas of innovation. It connects professionals managing science, technology and research parks (STPs) and other areas of innovation and provides services that drive growth and effectiveness for its members. The Association of clusters and Technology parks joined the International Association of Science Parks (IASP) in 2012.

IASP World Conference is the Olympic Games among technology parks and a key forum for meetings, networking and experience sharing between the leaders and chief executives of science parks and innovation development areas from all over the world. Every year, the conference is hosted by a different country, with the host technology park selected on a competitive basis two years prior to the conference. In a persistent struggle, the Skolkovo Technopark won the right to host IASP 2016. Russia was supported by technology parks from Asia, Europe and the United States. For Russian technology parks, the conference is a unique opportunity to share experience with the leading global experts, expand their networks of working contacts, discuss topical issues and find ways for cooperation and interaction with colleagues.

PROFILES OF SELECTED TECHNOLOGY PARKS

Skolkovo Technopark

The Skolkovo Technopark group of buildings is the center of the Skolkovo startups' lab-based research infrastructure. The technopark is one of the largest in Europe, and was designed by the eminent architectural bureau Valode & Pistre. The total area of the first stage of buildings is over 95,000 sq. m., with offices and labs occupying over 35,000. sq. m., and significant space allocated to exhibition and social facilities. The four-story building consists of two blocks connected by a gallery, and qualifies as Class B+ and LEED Silver environmental standard. Startups will be located there in accordance with a zoning plan based on the key innovative priorities of the Skolkovo Foundation. This planning scheme envisages a synergetic effect from the cooperation of companies engaged in research in complementary areas.

Skolkovo Technopark does not only provide office and lab facilities, but also maintains a service environment. More than 35 accredited service providers offer a wide range of R&D services, including prototyping, biomedical services, metrology, testing and certification. In 2015–2016, Skolkovo startups placed over 200 R&D service orders. Skolkovo startups also get access to a more than 10 business services, including accounting, legal, visa support, postal and marketing.

Innopolis

Innopolis is an innovation center located 30 kilometers from Kazan, the capital of Russia's Tatarstan republic. The first plans to build an IT center near Kazan date back to 2010 and were inspired by the idea of building a Russian Silicon Valley in Skolkovo. In July 2012, a capsule with a message to future city-dwellers was ceremonially placed at the building site. In November 2012, Prime Minister Dmitry Medvedev signed an order establishing the Innopolis special economic zone. The city's master plan was designed by the bureau RSP Architects Planners & Engineers, which is headed by Liu Thai Ker, the chief architect of Singapore. The opening ceremony of the innovation center took place on June 9, 2015. In September 2015, the first students started their studies at Innopolis, an innovative university developed in partnership with Carnegie Mellon University in the U.S. The university is the intellectual center of the new city, and focuses on IT educational and research programs. The academic staff consists of leading Russian and foreign experts in IT and robotics. A number of buildings have already been developed in the city, including the Popov technology park, the campus of Innopolis university, and residential and social infrastructure. Over the next 15 years, the innovation center will become a full-scale city with more than 150,000 inhabitants and 60,000 high-tech jobs.

Academpark Novosibirsk

Novosibirsk Akademgorodok has been famous for its R&D potential and is recognized as one of the key centers of R&D activities in Russia, both in fundamental and applied areas. Academpark Novosibirsk was founded in 2006 to become a core technology park of the Akademgorodok and foster commercialization and business activities. Technology park shareholders' are regional and local authorities, as well as academia (Siberian branch of the RAS). Academpark joined the government program supervised by the Ministry of Telecom and Mass Communications. Currently Academpark is an integrated technology park with a special research, technology and business infrastructure creating an ideal environment for the development of innovative startups and existing innovative businesses. There are more than 170 resident companies with 4500 employees. The total revenue of the resident companies accounts to RUB 9,5 bn (USD 150 mn).

Academpark has a cluster structure to provide a service and technology infrastructure for the development of all business dimensions of innovative companies, catering to their technology, organization, and logistics profile. The technology park's has four industrial clusters:

- Instrumentation and research intensive equipment;
- IT and telecommunications;
- Biotechnologies and biomedicine;
- New materials and nanotechnologies.

A cluster includes specialized business incubators, technology services and office and laboratory premises. The instrumentation cluster of Academpark already has an effective Technology Support Center (TSC). The Nanomodified Materials Center (NMMC) is currently being set up within the nanotech and new materials cluster in cooperation with Rusnano and SYGMA. Innovations. A dedicated datacenter is being organized within the IT cluster in cooperation with Rostelecom. Specialized chemical and biological laboratories are being created within the biotech and biomedicine cluster. The innovative business support infrastructure includes specialized Business Incubators (BIs), which provide support to startup entrepreneurs implementing innovative projects. BIs' objective is to set up 20 or more successful innovative startups per year. Academpark takes a proactive approach in educational programs and the development of a human resource pool. The annual Academpark Summer and Winter Schools not only contribute to the professional growth of graduate and postgraduate students, but also are a source of projects for BIs. The technology park is also setting up a Shared Resource Center (SRC) so that the tenant companies can run their business effectively and their employees can feel comfortable in Academpark. The SRC includes a hotel, conference hall, fitness center, and other objects of social and business infrastructure.

Technopark Mordovia

Technopark Mordovia is located in Saransk, Mordovia. The technology park was officially established in 2009. The technology park includes the following industrial clusters: energy-efficient lighting fixtures, electronic instrument, optoelectronics and fiber optics, information technology, composite materials and nanotechnology. Resident companies receive the following tax benefits: reduced profit tax rate (15.5% instead of 20%) and exemption of the property tax (2.2%). The companies can also benefit from financial support from the local budget (subsidies and government purchases). The infrastructure of the industrial park consists of two sites: Information and Computing Complex (ICC) and Innovative-industrial Complex (IIC). The total area of industrial facilities of the technology park accounts for 42,000 sq. m. The ICC provides facilities to the companies specialized in IT – software development, creation of information resources, etc. The IIC is a complex of office, laboratory and production facilities. It includes the following buildings: a center of energy-efficient lighting, a center for experimental production, a center for design innovation, an engineering center of fiber optics, a complex of office and laboratory space equipped with modern engineering services and technical equipment. Free flexible layout of the premises (office, industrial, laboratory and warehouse) allows residents and service companies of Technopark to organize their own working space according to individual requirements. It is possible to choose a set of services on the arrangement and planning of future jobs that are equipped with the necessary furniture and office equipment.

The Center of energy-efficient lighting is an R&D center providing facilities for scientific, technological and industrial activities in the field of a discharge and solid state lighting and lighting electronics. Anchor resident of the center is the Lodygin Research Institute of Lights, which has the scientific and industrial potential to develop, test, and produce almost all modern types of light sources. The Center for experimental production (CEP) is a center for collective use of modern high-tech equipment. It is intended for commercialization of innovative projects and pilot production of innovative products residents of Technopark. The Innovation Design Center (FIC) is a structural unit of industrial park, providing a full range of services from design of a product layout and development of software to prototype manufacturing and testing.

There are over 60 resident companies with more than 1600 employees. The overall revenue of the resident companies amounts to RUB 1.5 bn (USD 25 mn).

PART IV

EXPERIENCE OF TECHNOLOGY TRANSFER FROM RUSSIA TO CHINA

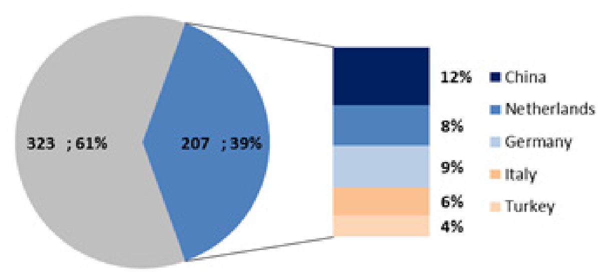
Russia – China economic cooperation

Fifteen years have passed since Russia and China signed the Treaty of Good-Neighborliness and Friendly Cooperation. Now it is time to assess the results achieved and set new milestones of 'the pivot to Asia' which was recently announced by the President of Russia.

In recent years, China has turned into the second largest export market and the first largest import market for the Russian Federation. The prominent role of China is quite easily explained, as the countries have more than 4,000 kilometers of joint border and history of over 400 years.

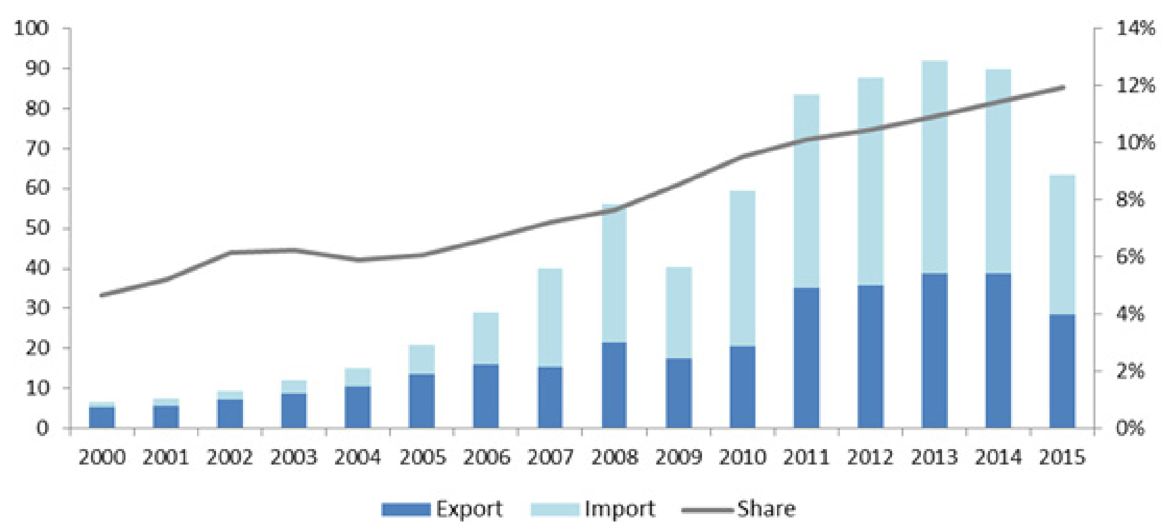
Exhibit 46 Top-5 trade partners of Russia, USD bn.

USD 530.4 bn = 100%



Source: Federal Customs Service, www.customs.ru

Exhibit 47 China's role in the Russian foreign trade (turnover, bn USD and share, %)



Source: UN Comtrade Database, www.customs.ru

Since the early 2000s, economic cooperation between Russia and China, including foreign trade, has been growing rapidly. The relative share of China in the total turnover of the Russian foreign trade has been steadily growing for the last 15 years. This positive trend sustained even the double shock of the combination of economic sanctions and the collapse of global natural resources prices. In 2015 China accounted for 12 percent of the total trade turnover compared to 5 percent in the early 2000s.

The relative stability of trade turnover demonstrates success of Russia's recent diversification strategy, which was focused on expanding exports to China and the rest of Asia. However the current trade model has risks and limitations which stems from its resource-based nature. The growth in foreign trade between Russia and China has been majorly fueled by the unprecedented demand for natural resources in China. Chinese economy has been demonstrating double digit growth rate for decades and demanded more and more natural resources such as crude oil, metals, wood, etc. The Chinese 'industrial machine' efficiently transformed them into consumer goods and machinery. High prices for natural resources allowed for currency inflow and in turn translated into purchases of Chinese goods by Russian companies.

This situation provided very limited incentives for the Russian companies to export products with higher value added, due to low prices for labor in China and disparity in currency rates (overvalued ruble). That is why the Russia's export was heavily dominated by raw materials, such as crude oil and round timber.

Table 25. Russia's export to China (2014 – 2015)

Item	2015		2014	
	Value, $ bn	%	Value, $ bn	%
Mineral fuel, oil and oil products	20.2	61%	29.8	71%
crude oil	17.2	52%	25.0	60%
Wood and materials of wood	3.1	9%	2.9	7%
Metals	3.0	9%	1.7	4%
Chemicals	1.1	3%	1.1	3%
Fish and sea products	1.2	4%	1.3	3%
Ores, slag and ash	0.9	3%	1.2	3%
Equipment and machinery	0.7	2%	0.5	1%
Other	3.1	9%	3.1	7%
Total	**33.3**	**100%**	**41.6**	**100%**

Source: Ministry of economic development of the RF, http://www.ved.gov.ru/

Table 26. Russia's import from China (2014 – 1H2015)

Item	2015		2014	
	Value, $ mn	%	Value, $ mn	%
Machines and equipment	12.5	36%	19.4	36%
Consumer goods, clothes and footwear	9.2	26%	16.0	30%
Chemicals and plastic products	3.2	9%	4.5	8%
Other	9.9	28%	13.8	26%
Total	**34.8**	**100%**	**53.7**	**100%**

Source: Ministry of economic development of the RF, http://www.ved.gov.ru/

This self-sustaining process has been losing momentum since 2014 as the economies of both Russia and China started passing through economic transition. Current slow-down of the Chinese economy and turn to The New Normal combined with development of green- and other efficiency-related technologies is likely to challenge a traditional resource-oriented pattern of the Russian export but at the same time will create new opportunities for more innovation-based goods and services, making more incentives for technology transfer. The Russian economy has also experienced a number of economic shocks: decreased prices for oil, gas and natural resources translated into lower budget revenues, liquidity problems induced by the Western sanctions and weakening domestic demand.

Change in macroeconomic conditions induced diversification of the Russian economy and created new opportunities for technology transfer and economic cooperation with China. Nowadays, based on the costs and time to delivery, it could be more profitable to launch production in Russia, which stimulates technology transition from China to Russia, for example in terms of knowhow. During the first official visit of China's new leader Xi Jinping to Moscow in March 2013, it was announced that the volume of bilateral trade would be raised to $100 billion in 2015 and $200 billion in 2020. After 3 years, the announced target seems challenging but is still achievable as by end of this year the overall trade turnover has bottomed up and started recovering. Moreover, the structure of trade is changing towards goods with higher value-added. In June 2016 during his visit to Beijing the President of Russia Vladimir Putin highlighted these positive changes. For example, export of machinery and equipment from Russia increased nearly two-fold and is growing. New opportunities were created in June 2016 as a number of documents have been signed including agreements on development of a wide-bodied passenger jet and a civil heavy helicopter. However, the potential of the technology transfer and cooperation in high-tech areas is yet to be unlocked, as China takes only 2 percent in the total amount of technology transfer turnover.

Table 27. Transfer of technologies: key countries, mn USD (2014)

Country	Export	Import
Total export	1 279	2 456
CIS countries	198	71
OECD	908	2 299
Turkey	363	163
USA	162	617
Italy	109	94
Germany	42	272
China	60	16

Source: S&T Indicators: 2016, Data Book. The National Research University Higher School of Economics by the Government of the RF (Table 6.21)

Support institutes and measures

What should be done to facilitate technology transfer from Russia to China and increase the share of high-tech exports? The answer is to build an efficient support system of state institutions complemented by efficient financial and non-financial instruments focused on high-tech export oriented companies and startups. China can provide excellent market opportunities, but this is a demanding and competitive market with its own rules, cultural and language practices. In this section we will present a brief overview of the current official bodies which support business community in Russia and complement this analysis with the results of information survey focused on high-tech SMEs.

First of all we start from the bodies which coordinate the economic cooperation and technology transfer on the top level. The key questions related to the mutual economic relations between Russia and China, including technology transfer is coordinated during regular meetings of heads of governments of both countries. The meetings are organized by the Russian-Chinese commission for preparing regular meeting of Heads of Government. The commission comprises 11 sub-commissions, for example on cooperation in energy sector, space technologies or telecommunications and IT sector. There are also 7 working groups which coordinate relations in terms of investment cooperation, special economic zones, IP protection and other topics. The official support to the export and import operations is provided by the Trade Representation of the Russian Federation, which is responsible for managing the formulation and implementation of the Russian trade policy. The Trade Representation has two offices – one in Beijing and Shanghai.

The financial and non-financial support to the exporting companies is provided by the Russian Export Center. The Russian Export Center is a state support institution, established as a part of Vnesheconombank with the support of the Government of the Russian Federation. Entrepreneurs can benefit from a full range of services, starting from initial consultations to assistance with export paperwork. The export insurance services are rendered by the Export Insurance Agency of Russia (EXIAR). The agency provides the insurance of export credit to cover against commercial and political risk. Since November 2014 Eximbank of Russia, a Russian specialized government-owned export-import bank has been a subsidiary of EXIAR. In acting as an agent of the Russian Government for providing government guarantees and financial support to Russia exports, Eximbank of Russia actively helps to widen the range of national exporters and their target countries, keep Russian companies competitive in the global market and launch import substitution.

There are also a number of organizations, rendering GR support and facilitating development of mutual projects, especially in the field of high-technologies. The Russian-Chinese chamber to promote trade on industrial and innovation products was founded in 2007 in order to provide a platform for networking and cooperation for Russian and Chinese companies, as well as facilitate joint export and manufacturing projects. The Chamber has the following subsections: aircraft and aerospace industries, power machinery, shipbuilding, telecommunications, automotive, electronics, new industrial technologies, construction industry. The Russian-Chinese Business Council was created in 2004 in order to promote development of mutual business projects and foster cooperation between Russian and Chinese business circles. Currently the Russian-Chinese Business Council supports over 25 large business projects with total value of more than $8.9 bn. These organizations are largely focused on large and to limited extent medium sized enterprises.

There are also a number of consulting companies which assist Russian companies in entering the Chinese market. The key services which are provided include marketing services, including search of suppliers of goods, organization of business-tours and visiting of exhibitions, legal support, on sight quality control and logistics services. These companies are open for SMEs, but mostly focus on the import of consumer goods.

The extensive search in open sources has failed to reveal any service provider with specialization on high-tech or technology transfer. The easiest explanation is that there is no market demand on these services. From the first sight this seem to be true, as the majority of SMEs specialize on consumer goods import, and large companies exporting natural resources do not need any additional consulting support. But is this really true? In order to find a proper answer to this question we have decided to conduct an information survey.

Information survey on cooperation with China

Methodology and approach of information survey

Our information survey is the first research of this kind in Russia. In our opinion SME sector has huge but still unlocked or underestimated potential of high-technologies and innovations. However in the previous years, all these companies usually turned out to be under the radar, only a few success stories became well known. The current statistical data provides very limited information on the involvement of Russia's SME sector in export and import operations related to high-technology products, as well as involvement of private companies in technology transfer.

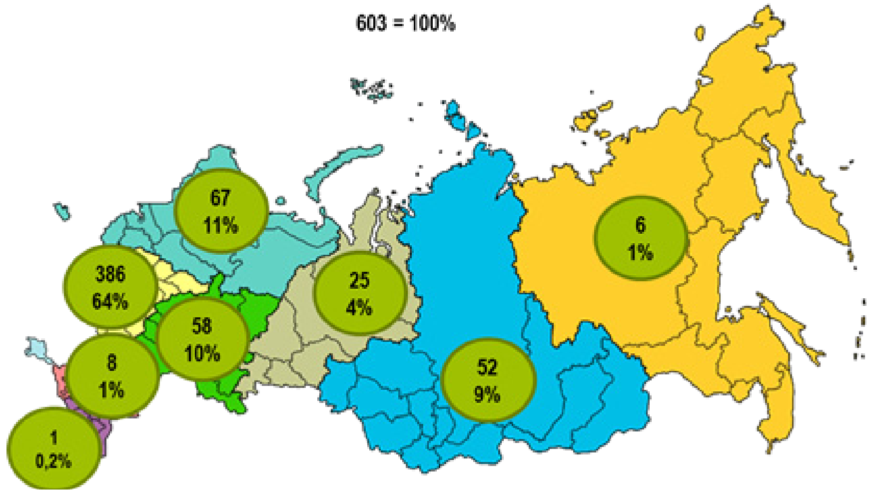
The following survey was designed to cover this information gap and collect information among SME on their level of interest and practical experience of cooperation with China in the field of technology transfer. Survey data and info from focus groups provide unique feedback from SMEs on their experience on the Chinese market. The survey also provides insights into the real needs of SMEs, their problems and obstacles on the way to the market.

The survey was intended to cover the following set of topics:

- Company profile (industry, number of employees, revenue);
- Experience of cooperation with China in the technology transfer (positive / negative, problems, support needed from Russia and China);
- Evaluation of the prospects of entering the Chinese market (plans and timing for entering);
- Target industries, forms and geography (industries, forms of interaction, and regions of China, interest in the patenting and legal support).

The target audience of the survey was the Russian high-technology small and medium enterprises involved in the Skolkovo project or which participated in the international event Startup Village 2015. Currently more than 1200 enterprises from 52 regions of Russia received a status of the Skolkovo project participants. This is a group of companies which have passed elaborate selection process and their projects have been verified by the expert panel of the Foundation.

Exhibit 48 Regional distribution of respondents



The total number of respondents accounted for 603 (of which 90% are Skolkovo startups). More than 60% of the respondents are located in Moscow and Moscow region; the other 40% are companies from all over Russia located in more than 20 major cities, including Vladivostok and Khabarovsk.
The participants of the survey represent SMEs, below are the key indicators of their demography.

Table 28. Distribution of participants by personnel

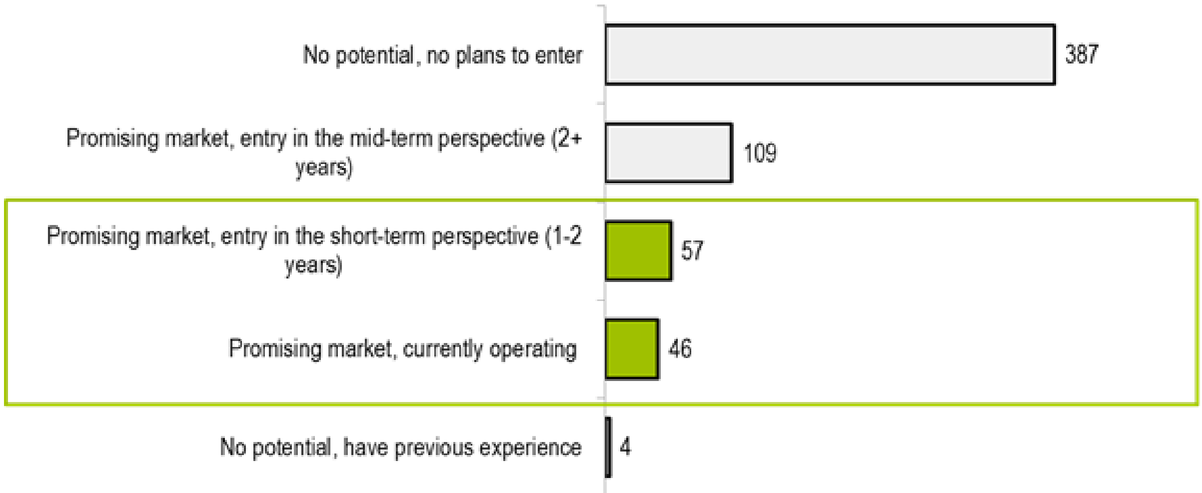
Category, by number of staff	Respondents	
	Number of companies	Share in total, %
0-10 people	456	76%
10-50	119	20%
50-100	16	3%
100-500	11	2%
500+	1	0%
Total	**603**	**100%**

Table 29. Distribution of participants by revenue

Category, by revenue	Respondents	
	Number of companies	Share in total, %
USD 0-1M (RUB 0-60M)	565	94%
USD 2 – 6.6M (RUB 60-400M)	32	5%
USD 6.6 – 13.3M (RUB 400-800M)	4	1%
USD 13.3 – 33.3M (RUB 800-2000M)	1	0%
USD 33.3M+ (RUB 2000M+)	1	0%
Total	**603**	**100%**

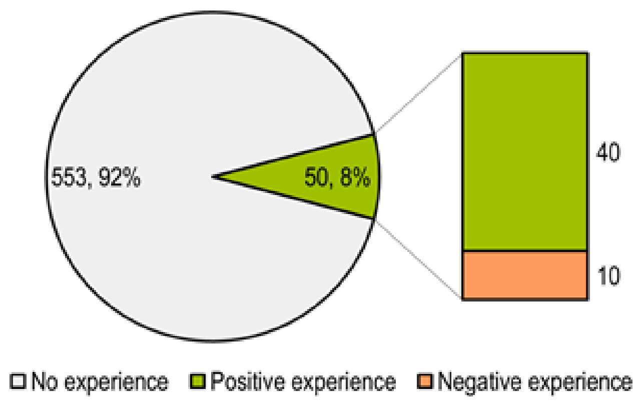
Key findings
More than one third of respondents (35 percent) expressed interest in entering the Chinese market or have already been working there.
What is more important, almost 50 percent of startups who expressed interest in the Chinese market either have already entered it or are planning to enter it in the short term perspective.

Exhibit 49 Intentions to enter the Chinese market



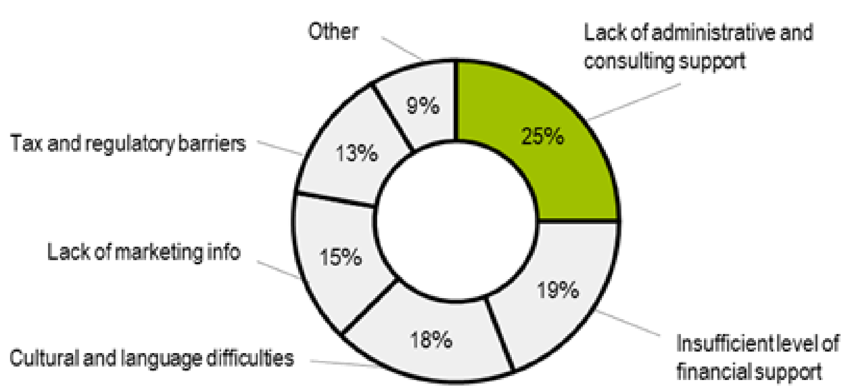
Chinese market is very large and promising, but on a practical level it is not penetrated by the Russian companies, as only 8 percent of respondents (50 out of 603) indicated actual experience of cooperation with the Chinese partners. The majority of companies (80 percent) have evaluated the experience as positive.

Exhibit 50 Experience of cooperation with China



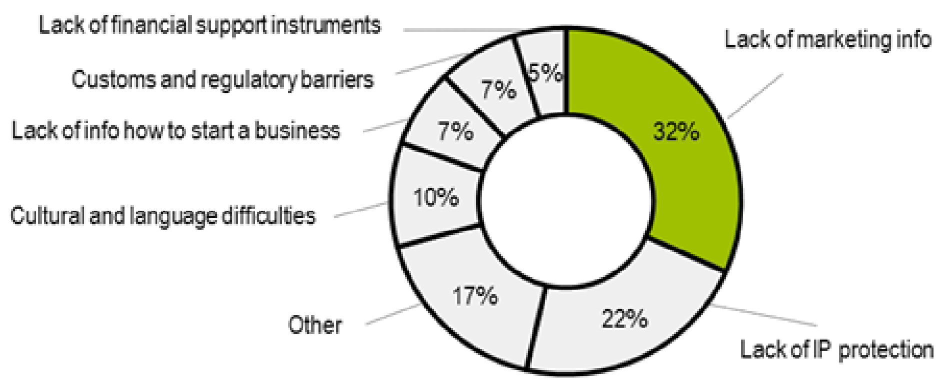
The survey has provided valuable insights into the problems which Russian startups faced while interacting with the Chinese partners.

Exhibit 51 Problems of companies which had experience of cooperation with China



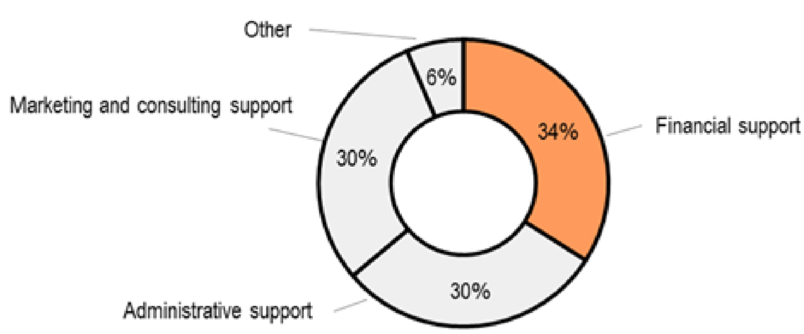
It is worth mentioning that the lack of administrative and consulting support was named the key problem (1st position, 25% votes). The insufficient level of financial support which is traditionally highlighted by all SMEs has taken the 2nd position (19% votes), slightly in advance of the cultural and language difficulties (3rd position, 18%). These features distinguish the Chinese market from others. Entering and operating on any new market is a difficult task for a startup, but hard language and differences in business cultures make this process especially hard. The lack of marketing info was named the most important problem (32 percent of votes) by companies, which do not have a real experience of cooperation with China.

Exhibit 52 Problems and fears of companies which do not have a real experience of cooperation with China

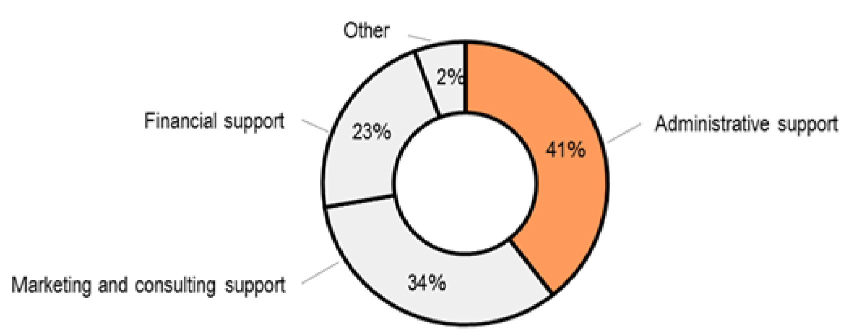


The lack of language skills and cultural difficulties could be a problem by itself, but for the first entrants it seems to hamper gathering initial knowledge on the market. In total, the limited information on the market, coupled with language and cultural difficulties, account for 42 percent of votes, and seem to be the tough barrier towards development of cooperation. The insufficient level of IP protection and fear of illegal copying is a widespread among the startups (22 percent of votes). In this regard, the startups' most demanded support measures include administrative, marketing and consulting support (both from the Chinese and Russian authorities).

Exhibit 53 Russian authorities: required measures of support

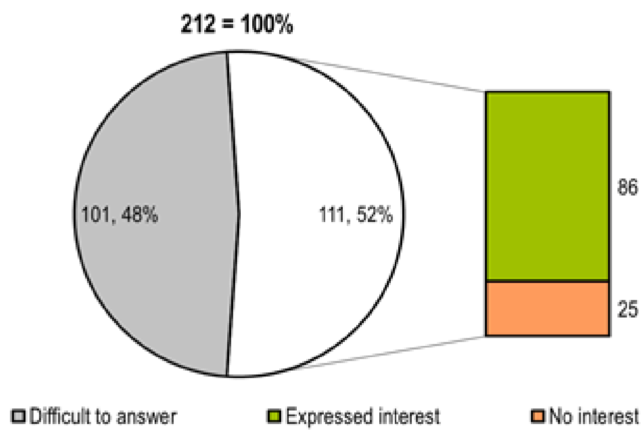


Chinese authorities: required measures of support



The legal and IP protection services is a hot topic for those who want to enter the Chinese market (86 respondents or 41 percent) expressed interest in such services.

Exhibit 54 Demand for patenting and legal support services in China



These results are interesting to compare with the findings on the key foreign trade barriers by the Expert Center under the Government of the Russian Federation.

Table 30. Key foreign trade barriers

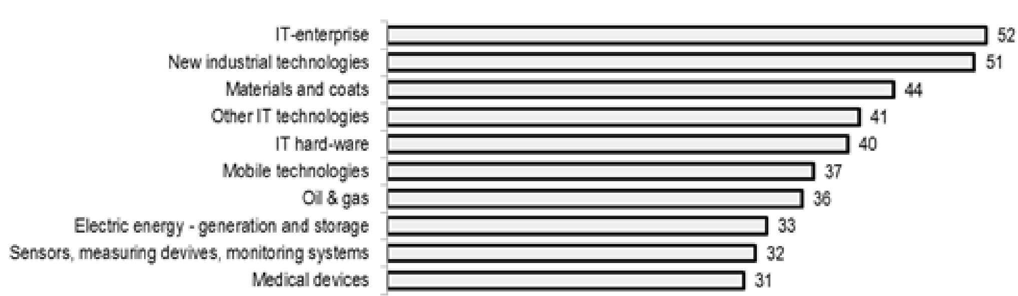
Description	Respondents' votes	
	SMEs	Large business
Lack of marketing info	39%	33%
Export procedures are difficult, take long time or expensive	38%	19%
Lack of IP protection	36%	19%
Import procedures are difficult, take long time or expensive	31%	27%

Source: Innovative strategy 2020: assessment of development, Expert Center under the Government of the Russian Federation

The wording of outcomes slightly differs, but the problems in general are the same: insufficient marketing information, lack of administrative and consulting support to follow the export and import regulation, as well as fears of insufficient IP protection.

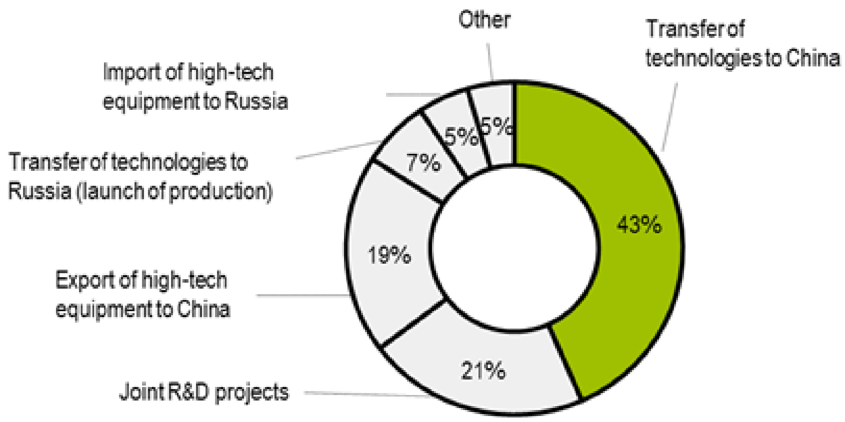
The survey was also intended to identify the key areas of interest and preferred forms for technology transfer.

Exhibit 55 Technology fields for cooperation



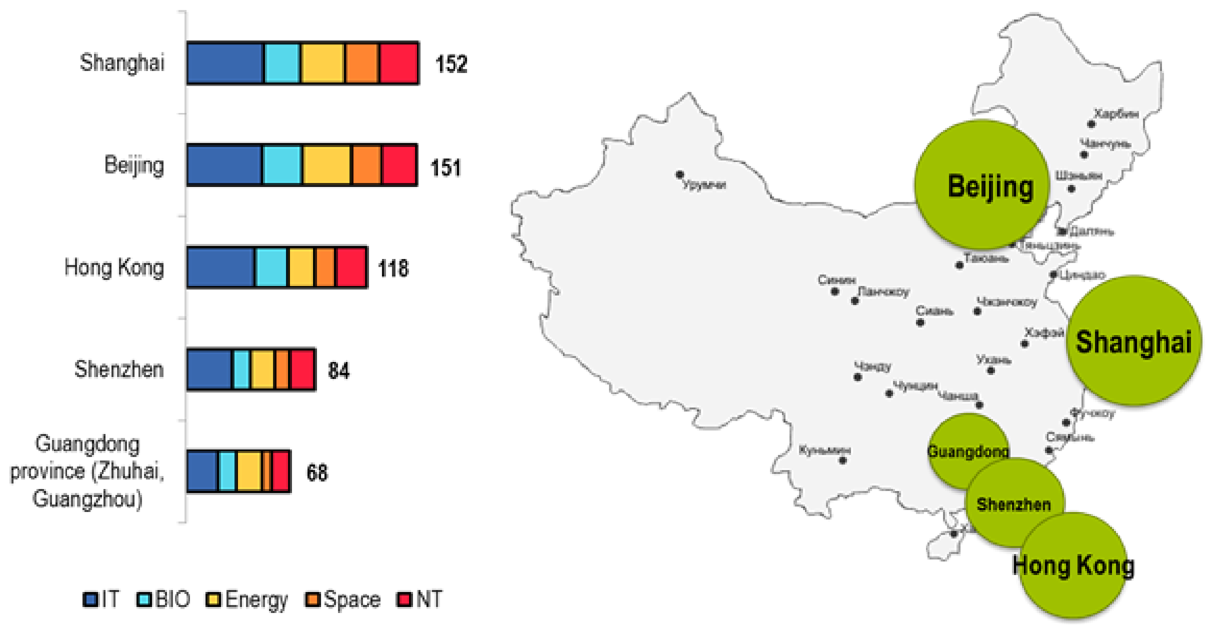
The top-5 preferred areas are formed by IT (IT-enterprise, IT hardware, Mobile technologies) and industrial technologies (new industrial technologies, and materials and coatings), so the technology transfer is heavily focused on B2B solutions. Russian startups are focused on transfer of technologies and high-tech equipment to China as well as pursuing joint R&D projects.

Exhibit 56 Preferred forms of technology transfer cooperation



The survey made it possible to map the preferred cities of China for the market entry.

Exhibit 57 China's most attractive cities



Suggestions

Based on the survey, there's a significant but still unlocked potential of economic cooperation between Russia and China in terms of technology transfer. Russian SMEs want to enter the Chinese market, but lack of marketing info and limited awareness on the support measures hamper their activities.

What should be done to break the ice and facilitate the knowledge transfer and hi-tech trade? Summarizing the findings, there are a number of high demand services, required by SMEs planning to enter the Chinese market:

- *Organizational and administrative support:* assistance in finding an office, hiring personnel, support on registering a legal entity, opening bank accounts, tax registration, etc.
- *Information and analytical support:* market research and analysis, consulting support on the market entry.
- *Acceleration and business development support:* assistance in building a network of partners with industrial companies, investors, representatives of the government authorities.

The most efficient way is to structure support measures based on the current system of development institutions, technology parks and innovation centers. Representative offices of development institutions located in the key technology parks and innovation centers can be connecting points, linking technology transfer routes between countries.

Basing on the survey results, Skolkovo Foundation has ventured to launch a pilot project of representative office in China. This representative office will be a window to China, providing access of Skolkovo startups to the Chinese markets. The key goals of the representative office will be commercialization of technologies, attraction of investments in Skolkovo companies and infrastructure, as well as provision of commercial services on dealing with the Chinese partners. The representative office will also become an entry point for the Chinese investors to invest in Skolkovo startups.

CONCLUSION AND SUMMARY OF FINDINGS:

Over the past few decades, China's national innovation system has demonstrated an outstanding performance. One of the key factors of its innovative development was a targeted government policy aimed at opening up the economy and attracting investment and technologies, as well as the development of infrastructure and innovation competencies. Chinese companies have gained a strong position in the world's markets, where the key competitive factor is efficiency-driven innovation. Strong economic growth has contributed to the formation of a vast domestic market and fostered the development of customer-focused innovative firms. Nevertheless, the old model of economic development, labeled by the brand "Made in China" can no longer maintain sustainable economic growth, as the competitive advantages of low-wage labor and a high return on capital are gradually being exhausted. The future of the Chinese economy is inevitably linked to the development of scientific and technological capacity and the innovation system, where the important role will be played by innovators and high-tech small and medium-sized enterprises.

The new model of Russia's economic growth is also dependent on innovation and the development of high-tech industries. The development model focused on exporting natural resources has achieved a qualitative leap and narrowed the gap with the leaders, but it is not conducive to obtaining the leading positions in the emerging high-tech world. The future of Russia is linked to development of a new economic model based on knowledge-intensive high-tech production, export of technology, rather than raw materials, creation and ensuring the leading positions on new markets and technological trends. Cooperation in innovative projects between the two countries, including such fields as civil aviation and high-speed railways, will unite the complementary innovative competencies of both countries and make it possible to achieve significant synergies. In this case, as shown by the results of an information survey among Russian startups, significant potential for cooperation exists, not only for large companies but also for high-tech small and medium-sized enterprises.

It is also important to study the successful experience of China's public policies to support innovation. The system of Russia's development institutions can act as a bridge between the public sector and business, which will increase the involvement of companies in innovation and technological entrepreneurship.